ASSESSMENT OF AGRICULTURAL EXTENSION NEEDS OF FARMERS FOR DISASTER RESILIENCE IN DHEMAJI DISTRICT OF ASSAM

A

Thesis

Submitted to

Uttar Banga Krishi Viswavidyalaya

In partial fulfillment of the requirement for the

Award of the Degree of

DOCTOR OF PHILOSOPHY (AGRICULTURE)

IN

AGRICULTURAL EXTENSION

By

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(A-2020-10-D)

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2023

Dedicated to My Beloved

Parents

Kamini Barman

And

Deben Barman

APPROVAL OF EXAMINERS FOR THE AWARD OF THE DOCTORAL DEGREE (AGRICULTURE) IN AGRICULTURAL EXTENSION

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ABSTRACT

Title of the Thesis	**:**	**Assessment of Agricultural Extension Needs of Farmers for Disaster Resilience in Dhemaji district of Assam**
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Multiple disasters are imposing devastating consequences on agriculture, food security and the livelihoods of millions of farmers.In a developing country like India, the majority of the people live in rural areas and depend on agriculture for their livelihood. In such a situation building farmer disaster resilience is needed to improve adaptive capacities for future farm disasters. Extension and advisory services may play a critical role in promoting agriculture and rural development and improving the resilience of the agricultural sector. In this perspective, the present study was conducted in flood-prone areas of Dhemaji district of Assam with an aim to assess the agricultural extension needs of farmers for disaster resilience. A multistage purposive cum random sampling design was followed for selecting the 200 farmer respondents for the study. With respect to the selected attributes of the respondents, the study revealed that most of the respondents were under the age group of 32-61 years having 10-39 years of farming experience with medium level of family education status, possessing 1.20-3.20 ha size of operational land holding, belonging to the annual income group of Rs1,15000/ - Rs 2,87000.Majority of the respondents had medium level of social participation, extension contact, training exposure, innovativeness, economic motivation, scientific orientation, management orientation, risk bearing ability and emotional intelligence. While computing farmer resilience index, it was found that over half majority of the respondents belonged to medium level farmer resilience index. The variables annual expenditure, scientific orientation and extension contact

are positively and significantly contributing towards characterizing the farmer resilience index**.** The eighteen predictor variables put together have explained 42.20% variation embedded with the farmer resilience index. Neural network analysis indicates that the variable farming experience has the maximum level of influence followed by annual expenditure, mass media exposure and others in explaining, farmer resilience index. Fuzzy cognitive mapping states that components income, education, knowledge of crop/ farm diversification, operational land holding and training exposure have significant impact in enhancing farmers' disaster resilience. In assessing the agricultural extension needs, the study showed that the major farmers' agricultural information needs are flood and drought-resistant varieties; disease and pest-resistant varieties; HYVs and hybrid seeds; subsidy and crop insurance; preparedness against natural calamities and current prices of agricultural produce. Efficient use of seeds, fertilizer and measures of plant protection; flood and drought-resistant crop varieties; preparedness/crop contingency planning; entrepreneurship development and custom hiring centre are the major agricultural training and demonstration needs as perceived by most farmers. The major farmers' agricultural disaster mitigation strategy needs are cultivating flood-tolerant rice varieties, practicing in-situ rainwater harvesting for moisture conservation (mulching), and practicing mixed cropping and intercropping. The study also indicated that lack of exposure to agricultural development, inadequate access to training and demonstration and lack of crop insurance facilities, unpredictability nature of disaster events,various types/natures of disasters and their changing magnitude level, lack of irrigation facilities, non-availability cold storage facilities, lack of agricultural shop nearby, lack of custom hiring centre were rated as major challenges experienced by the most of the farmer respondents. A holistic and massive farmer-friendly agricultural extension system or farm disaster extension system should be evolved based on the farmers' needs and challenges and developed paradigms through FCM and other relational analyses covering all aspects of farm disaster management ensuring reach to all farmers of vulnerable areas.

Key words: Farmers'* disaster resilience, *Climate change, Food security, Weather extreme, Natural hazards, Fuzzy Cognitive Mapping, Agricultural extension needs, Disaster resilient challenges, Farmers' resilience.

Contents

Chapter No.	*Particulars*	*Page No.*
1	**Introduction**	1-9
2	**Review of Literature**	10-37
3	**Theoretical Orientation**	38-54
4	**Research Methodology**	55-81
4.1	Locale of research	55
4.2	Research design	56
4.3	Sampling design	57
4.4	Pilot study	58
4.5	Hypothesis	58
4.6	Conceptualization, Operationalization and measurement of variables	59
4.7	Method of data collection	73
4.8	Statistical and other tools used for the analysis of data	74
5	**Research Setting**	82-98
5.1.2	Description of the state (Assam)	83
5.1.3	Description of North Bank Plain Agro-Climatic Zone	85
5.1.4	A brief description of Dhemaji district	88
5.2.1	Brief about the selected blocks	93
5.2.2	Brief about the selected villages	95
6	**Results and Discussion**	99-222
	PART-I	
6.1	Attributes of farmers in the study area	99
6.2	Computation of Farmer Disaster Resilience	119
6.3	Factors associated with the Farmer resilience index	128
6.4	Agricultural extension needs of Farmer for disaster resilience	178
6.5	Challenges associated with farmers' agricultural extension needs and disaster resilience	196
6.6	Strategic paradigm for farmers' agricultural extension needs and disaster resilience	203
6.7	Accepted hypothesis	218
	PART-II	
	Success Story-A	219
	Success Story-B	220
	Success Story-C	221
7	**Summary and Conclusion**	223-235
7.1	Summary	223
7.2	Conclusion and Recommendation	231
	Future scope of research	235-236
	Bibliography	i-xviii
	Appendix	I-XV

List of Tables

Table No.	*Particulars*	*Page No.*
1.1	Frequency and Impactofdisasters:1980-1999 and 2000-2019	2
1.2	Global occurrence of different types of disaster during 2000-2019 and in 2020	3
1.3	Disaster Related challenges in Indian Agriculture	5
3.1	Disaster Related challenges in Agriculture	44
3.2	Risk associated with different Division of Ministry of Agriculture and Farmers Welfare	45
4.1	Variables selected for the present study and their empirical measurement	73
6.1	Distribution of the respondents according to their age(X_1)	99
6.2	Distribution of the respondents according to their family education status(X_2)	100
6.3	Distribution of the respondents according to their farming experience(X_3)	101
6.4	Distribution of the respondents according to their family size(X_4)	102
6.5	Distribution of the respondents according to their size of operational land holding(X_5)	103
6.6	Distribution of the respondents according to their cropping intensity(X_6)	104
6.7	Distribution of the respondents according to their annual income(X_7)	105
6.8	Distribution of the respondents according to their Annual expenditure(X_8)	106
6.9	Distribution of the respondents according to their social participation (X_9)	107
6.10(a)	Distribution of the respondents according to their Extension contact (X_{10})	108
6.10(b)	Distribution of the respondents according to their frequency of Extension contact (X_{10})	109
6.11(a)	Distribution of the respondents according to their Mass media exposure (X_{11})	110
6.11(b)	Distribution of the respondents according to their frequency of Mass media exposure (X_{11})	111
6.12	Distribution of the respondents according to their Training exposure (X_{12})	112
6.13	Distribution of the respondents according to their Innovativeness (X_{13})	113
6.14	Distribution of the respondents according to their Economic motivation(X_{14})	114
6.15	Distribution of the respondents according to their Scientific orientation(X_{15})	115

6.16	Distribution of the respondents according to their Management orientation(X_{16})	116
6.17	Distribution of the respondents according to their Risk bearing ability(X_{17})	117
6.18	Distribution of the respondents according to their Emotional intelligence(X_{18})	118
6.19	Distribution of the respondents according to their Economic resilience index (Y_1)	119
6.20	Distribution of the Mean Weightage Score according to the indicators of Economic resilience index (Y_1)	120
6.21	Distribution of the respondents according to their Social resilience index (Y_2)	121
6.22	Distribution of the Mean Weightage Score according to the indicators of Social resilience index (Y_2)	122
6.23	Distribution of the respondents according to their Technical resilience index (Y_3)	123
6.24	Distribution of the Mean Weightage Score according to the indicators of Technical resilience index (Y_3)	124
6.25	Distribution of the respondents according to their Physical resilience index (Y_4)	125
6.26	Distribution of the Mean Weightage Score according to the indicators of physical resilience index (Y_4)	126
6.27	Distribution of the respondents according to Farmer resilience index (Y_5)	127
6.28	Coefficient of correlation(r) between Economic resilience index (Y_1) and 18 causal variables	128
6.29	Stepwise Regression: Economic resilience index vs. 18 causal variables	134
6.30	Coefficient of correlation(r) between Social resilience index (Y_2) and 18 causal variables	137
6.31	Stepwise Regression: Social resilience index vs. 18 causal variables	131
6.32	Coefficient of correlation(r) between Technical resilience index (Y_3) and 18 causal variables	146
6.33	Stepwise Regression: Technical resilience index vs. 18 causal variables	151
6.34	Coefficient of correlation(r) between Physical resilience index (Y_4) and 18 causal variables	157
6.35	Stepwise Regression: Physical resilience index vs. 18 causal variables	162
6.36	Coefficient of correlation(r) between Farmer resilience index (Y_5) and 18 causal variables	165
6.37	Stepwise Regression Farmer resilience index vs. 18 causal variables	171
6.38	Analysis of variance for farmer resilience index of villages	174
6.39	Factor analysis of the variables by principal component analysis in relation to farmer disaster resilience	175

6.40	Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of agricultural inputs under up to date Information dimension	179
6.41	Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of agricultural finance under up to date Information dimension	181
6.42	Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of agricultural production under up to date Information dimension	182
6.43	Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of Post harvest management under up to date Information dimension	184
6.44	Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of Marketing under up to date Information dimension	185
6.45	Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of livelihood diversification under up to date Information dimension	186
6.46	Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of agricultural inputs under Advisory Service (Training & Demonstration) dimension	187
6.47	Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of agricultural finance under Advisory Service (Training & Demonstration) dimension	188
6.48	Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of agricultural production under Advisory Service (Training & Demonstration) dimension	189
6.49	Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of post harvest management under Advisory Service (Training & Demonstration) dimension	191
6.50	Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of livelihoods diversification under Advisory Service (Training & Demonstration) dimension	192
6.51	Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of Agricultural production under Mitigation strategy dimension	194
6.52	Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of Institutional Building under Mitigation Strategy dimension	195
6.53	Garrett's ranking of respondents' Socio economic challenges associated with agricultural extension needs and disaster resilience	197
6.54	Garrett's ranking of respondents' Technical challenges associated with agricultural extension needs and disaster resilience	199
6.55	Garrett's ranking of respondents' Physical and Infrastructural challenges associated with agricultural extension needs and disaster resilience	200

6.56	Garrett's ranking of respondents' Organizational/Institutional challenges associated with agricultural extension needs and disaster resilience	201
6.57	The sub components for each of the key components	204
6.58	Characteristics the collective average-FCM	207
6.59	Mean values of significance for two blocks and the average degree of significance	209
6.60	The average degree of significance and centrality values of all key components	210
6.61	The Key components selected for scenario development	211

List of Figures

Figure No.	*Particulars*	*Page No.*
3.1	Crop cycle and associated Hazards	44
3.2	The relationship between vulnerability, resilience, and adaptation.	51
4.1	Sampling design of the study	57
4.2	Hypothesis for the study	58
5.1	Map of Assam depicting the districts	85
5.2	Map of Assam depicting the Agro-Climatic Zone	86
5.3	Map of Dhemaji district depicting the Community Development Block	90
6.1	Diagrammatic representation of the respondents according to their age(X_1)	100
6.2	Diagrammatic representation of the respondents according to their family education status(X_2)	100
6.3	Diagrammatic representation of the respondents according to their farming experience(X_3)	101
6.4	Diagrammatic representation of the respondents according to their family size(X_4)	102
6.5	Diagrammatic representation of the respondents according to their size of operational land holding(X_5)	103
6.6	Diagrammatic representation of the respondents according to their cropping intensity(X_6)	104
6.7	Diagrammatic representation of the respondents according to their annual income(X_7)	105
6.8	Diagrammatic representation of the respondents according to their Annual expenditure(X_8)	106
6.9	Diagrammatic representation of the respondents according to their social participation (X_9)	107
6.10(a)	Diagrammatic representation of the respondents according to their Extension contact (X_{10})	108
6.11(a)	Diagrammatic representation of the respondents according to their Mass media exposure (X_{11})	110
6.12	Diagrammatic representation of the respondents according to their Training exposure (X_{12})	112
6.13	Diagrammatic representation of the respondents according to their Innovativeness (X_{13})	113
6.14	Diagrammatic representation of the respondents according to their Economic motivation(X_{14})	114
6.15	Diagrammatic representation of the respondents according to their Scientific orientation(X_{15})	115
6.16	Diagrammatic representation of the respondents according to their Management orientation(X_{16})	116

6.17	Diagrammatic representation of the respondents according to their Risk bearing ability(X_{17})	117
6.18	Diagrammatic representation of the respondents according to their Emotional intelligence(X_{18})	118
6.19	Diagrammatic representation of the respondents according to their Economic resilience index (Y_1)	119
6.20	Diagrammatic representation of the respondents according to their Social resilience index (Y_2)	121
6.21	Diagrammatic representation of the respondents according to their Technical resilience index (Y_3)	123
6.22	Diagrammatic representation of the respondents according to their Physical resilience index (Y_4)	125
6.23	Diagrammatic representation of the respondents according to Farmer resilience index (Y_5)	127
6.24	Diagrammatic representation of Coefficient of correlation(r) between Economic resilience index (Y_1) and 18 causal variables	129
6.25	Diagrammatic representation of Stepwise Regression: Economic resilience index vs. 18 causal variables	125
6.26	Diagrammatic representation of Coefficient of correlation(r) between Social resilience index (Y_2) and 18 causal variables	128
6.27	Diagrammatic representation of Stepwise Regression: Social resilience index vs. 18 causal variables	142
6.28	Diagrammatic representation of Coefficient of correlation(r) between Technical resilience index (Y_3) and 18causal variables	147
6.29	Diagrammatic representation of Stepwise Regression: Technical resilience index vs. 18 causal variables	152
6.30	Diagrammatic representation of Coefficient of correlation(r) between Physical resilience index (Y_1) and 18 causal variables	158
6.31	Diagrammatic representation of Stepwise Regression: Physical resilience index vs. 18 causal variables	162
6.32	Diagrammatic representation of Coefficient of correlation(r) between Farmer resilience index (Y_5) and 18 causal variables	166
6.33	Diagrammatic representation of Stepwise Regression: Farmer resilience index vs. 18 causal variables	172
6.34	Artificial Neural Network of predictor variables(X_1-X_{18}) with respect to predicted variables (Y_1-Y_5)	177
6.35	Normalized importance diagram of predicted variables with respect to 18 predictor variables	178
6.36	Diagrammatic representation of Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of agricultural finance under up to date Information dimension	181
6.37	Diagrammatic representation of Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of agricultural production under up to date Information dimension	183

6.38	Diagrammatic representation of Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of Post harvest management under up to date Information dimension	184
6.39	Diagrammatic representation of Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of Marketing under up to date Information dimension	185
6.40	Diagrammatic representation of Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of Post harvest management under up to date Information dimension	186
6.41	Diagrammatic representation of Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of agricultural inputs under Advisory Service (Training & Demonstration) dimension	188
6.42	Diagrammatic representation of Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of agricultural finance under Advisory Service (Training & Demonstration) dimension	189
6.43	Diagrammatic representation of Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of agricultural production under Advisory Service (Training & Demonstration) dimension	190
6.44	Diagrammatic representation of Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of post harvest management under Advisory Service (Training & Demonstration) dimension	191
6.45	Diagrammatic representation of Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of livelihoods diversification under Advisory Service (Training & Demonstration) dimension	193
6.46	Diagrammatic representation of Garrett's ranking of respondents' preferences of agricultural extension needs on the thematic area of Institutional Building under Mitigation Strategy dimension	196
6.47	Diagrammatic representation of Garrett's ranking of respondents' Socio economic challenges associated with agricultural extension needs and disaster resilience	198
6.48	Diagrammatic representation of Garrett's ranking of respondents' Physical and Infrastructural challenges associated with agricultural extension needs and disaster resilience	200
6.49	Diagrammatic representation of Garrett's ranking of respondents' Organizational/Institutional challenges associated with agricultural extension needs and disaster resilience	202
6.50	Expert based FCM Model on farmer disaster resilience	203
6.51	Farmer based FCM Model on farmer disaster resilience	206
6.52	Diagrammatic representation of simulated effect of Income on others key components	212

6.53	Diagrammatic representation of simulated effect of Education on others key components	213
6.54	Diagrammatic representation of simulated effect of Training exposure on other key components	214
6.55	Strategic Paradigm-II for farmers' disaster resilience	215
6.56	Strategic Paradigm-III for farmers' disaster resilience	217

ABBREVIATION

IPCC	:	Intergovernmental Panel on Climate Change
INCCA	:	Indian Network on Climate Change Assessment
ha	:	Hectare
HYV	:	High Yielding Variety
EM-DAT	:	Emergency Event Data Base
GKMS	:	Gramin Krishi Mausam Sewa
FPO	:	Farmer Producer Organization
FPC	:	Farmer Producer company
USD	:	United States dollar
CHC	:	Custom Hiring Centre
DRM	:	Disaster Risk Management
NADMP	:	National Agriculture Disaster Management Plan
NDMA	:	National Disaster Management Authority
MoAFW	:	Ministry of Agriculture &Farmers Welfare
NIDM	:	National Institute of Disaster Management
NDRF	:	National Disaster Response Force
SDG	:	Sustainable Development Goal
SFDRR	:	Sendai Framework for Disaster Risk Reduction
NICRA	:	National Innovation on Climate Resilient Agriculture
NMSA	:	National Mission for Sustainable Agriculture
NHID	:	Natural Hazards-Induced Disasters
OECD	:	The Organization for Economic Cooperation and Development
FAO	:	Food and Agricultural Organization
WB	:	World Bank
UNISDR	:	United Nations International Strategy for Disaster Reduction
LDC	:	Least developed countries (LDCs)
LMIC	:	Low- and middle-income countries (LMICs)
HIC	:	High-income countries (HICs
UMIC	:	Upper-middle income countries (UMICs)
ADO	:	Agricultural Development Officer
VLEW	:	Village Level Extension worker
AEA	:	Agricultural Extension Assistant
ATMA	:	Agricultural Technology Management Agency
NGO	:	Non Governmental Organization
IMD	:	India Meteorological Department
KVK	:	Krishi Vigyan Kendra
PMAY	:	Prime Minister Awas Yojana
IAY	:	Indira Awas Yojana
FIG	:	Farmer Interest Group
SHG	:	Self Help Group
PMFBY	:	Pradhan Mantri Fasal Bima Yojana
MGNREGA	:	Mahatma Gandhi National Employment Assurance Scheme

CHAPTER-I



INTRODUCTION

In the context of global climate change, extension and advisory services encounter various challenges including natural disaster, adaptation, and rebuilding post-disaster. Small and marginal farmers are more vulnerable to such climate shocks and weather-related disasters. It is stated that most of the farmers lack the knowledge and resources to adequately mitigate, anticipate, prepare for, cope with, and recover from disaster shocks. Extension and advisory services may play a critical role in promoting agriculture and rural development and improving the resilience of the agricultural sector. These extension services may offer an opportunity to strengthen the resilience of rural and farming communities/households by increasing their access to agricultural inputs, knowledge and skills.

Agriculture is a lifeline for many countries as the majority of people are involved in agriculture and its allied activities for their livelihoods and thus agriculture plays a vital role in the economies of developing and underdeveloped countries. Agriculture is highly sensitive to climate changes and extreme weather events such as droughts, floods and severe storms, which have a direct negative impact on crop production, productivity and other agricultural production bases posing a threat to the livelihood and food security of millions of farmers. Owing to global warming and other climatic changes that lead to weather extremes or abnormalities, world agriculture is facing challenges in producing adequate food, feed, fibre and industrial products, to meet the ever-growing needs of billions of populations. Almost 2.5 billion people worldwide depend on agriculture for their livelihoods. At the same time, agriculture is highly vulnerable to the impacts of recurrent disasters and other types of crises. In recent years multiple disasters have imposed devastating consequences on agriculture, food security and the livelihoods of millions of farmers. Staple food production in many agriculture-based countries remains largely rain-fed and uninsured against the large fluctuations caused by weather and climatic variability. The agriculture sector often faces multipronged and long-lasting consequences of disasters, such as the deterioration of soil and animal health, contamination of aquaculture facilities, loss of harvests, outbreaks of disease or destruction of irrigation systems and other infrastructure. Such impacts can be particularly detrimental in underdeveloped or developing countries, where agriculture tends to be the economic backbone, often contributing up to 20–30 percent of national GDP and employment. Over time the frequency and intensity of natural disasters are increasing across the Globe and the agricultural production base is being damaged and thereby many farmers are losing their livelihoods or being marginalized. Natural disasters mainly floods, draughts, cyclones and hailstorms are posing a threat to food and livelihood security for millions of

people. Three global landmark agreements adopted in 2015 – the *Sendai Framework for Disaster Risk Reduction 2015–2030*, the Sustainable Development Goals (SDGs) and the Paris Agreement on Climate Change – recognize the importance of disaster risk reduction and resilience. They also acknowledge the crucial role of agriculture in risk-sensitive and sustainable development.

An increasing trend can also be observed in recent decades regarding weather- and climate-related disasters. These types of disasters include, for example, drought, extreme temperatures, storms, heavy rainfall events and floods. It is estimated that during these two periods of 1980-1999 and 2000-2019, around 87% and 91% of the total number of natural hazard-induced disasters were weather- and climate-related. The number of people affected by these types of disasters has increased – from 3.25 billion in 1980-1999 to 4.03 billion people in 2000-2019, while the economic losses caused amounted to USD 2.97 trillion in 2000-2019, compared to USD 1.63 trillion in 1980-1999 (CRED and UNDRR, 2020). According to the international disaster database EM-DAT, at the global level, floods occurred the most frequently during 2000-2019 (44% of natural hazard-induced disasters), followed by storms (28%), earthquakes (8%), extreme temperatures (6%), and landslides and drought (5%). In terms of the impacts of these disasters on people, floods affected the largest number of people (41% of total people affected), followed by drought (35%), storms (18%) and earthquakes (3%) (CRED and UNDRR, 2020).

Table 1.1: Frequency and Impact of disasters: 1980-1999 and 2000-2019

Time period	Disaster frequency	Number of deaths (in million)	Number of people affected (in billion)	Economic losses (in trillion U.S.$)
1980-1999	4,212	1.19	3.25	1.63
2000-2019	7,348	1.23	4.03	2.97

Source : (EM-DAT,2020)

It is expected that with climate change, weather- and climate-related disasters will further increase in frequency and severity (IPCC, 2012). Due to the climate sensitivity of agriculture, the sector is already negatively impacted, as a result of damage to, and destruction of agricultural-related infrastructure, and losses in crops, livestock, forestry, fisheries and aquaculture production (FAO, 2016). Also, plant and animal pests and diseases are expected to rise due to climate change, extreme weather events and seasonal variability, and are already impacting the sector, food security and agricultural livelihoods (FAO, 2005).

Moreover, the coronavirus disease 2019 (COVID-19) has globally spread and has devastated lives, livelihoods and economies worldwide. The COVID-19 pandemic unfolded on top of other shocks and stresses, such as floods, storms, earthquakes, droughts and desert locusts. Some of these disasters are linked or aggravated by the effects of climate change, which will further increase the exposure and vulnerabilities of people, societies and economies. The pandemic has shown the changing risk environment, as well as the systemic and overlaying nature of risks that have cascading adverse impacts on all sectors, including agriculture and food systems. Hence, a need for multi-hazard and multi-sectoral preventive and anticipatory approaches that ensure the integration of disaster, climate and crisis risk management to strengthen the resilience of people, their agricultural livelihoods and the ecosystems they depend upon.

Table 1.2: Global occurrence of different types of disaster during 2000-2019 and in 2020

Disaster Type	Time period	
	2000-2019	2020
Drought	17	9
Earthquake	28	16
Extreme temperature	22	5
Flood	163	201
Landslide	19	19
Storm	102	127
Volcanic activity	5	4
Wildfire	12	8

Source: (EM-DAT, 2021)

Natural hazard-induced disasters are a leading cause of food insecurity. The impact of these disasters extends beyond the economic realm – they destroy food, and people's ability to produce, access and intake food, which affects all four dimensions of food security by reducing the availability of food; limiting physical and socio-economic access to food; affecting food utilization, which refers to the body's ability to absorb the nutrients in food that is consumed; and, disasters undermine food stability at all times, as access, availability and utilization of food are disrupted (FAO, 2008). According to the FAO study (2021) in the agricultural sector between 2008 and 2018, 26% of the overall impacts were caused by medium- to large-scale disasters in least-developed countries (LDCs) and in low- and middle-

income countries (LMICs). During this period, around USD 108.5 billion was lost alone due to declines in crop and livestock production in LDCs and LMICs as a result of disasters. Across all income groups, including in the upper-middle income countries (UMICs) and high-income countries (HICs), loss in crop and livestock production amounted to USD 280 billion.

While the impacts of individual natural hazard events can be severe, natural hazard risk – and indeed, disaster risk more broadly – is becoming increasingly compound and interacting. Droughts and floods can trigger pest and disease outbreaks; weather-related hazards are expected to intensify and increase in frequency because of climate change (IPCC, 2013); and in many countries, natural hazards such as severe storms, droughts and pest outbreaks have compounded the effects of the COVID-19 pandemic on agriculture (FAO, 2021). Interlinkages between agriculture and other sectors and systems also mean that natural hazards can affect agriculture and disrupt farm business activities by interrupting or shutting down critical infrastructure for the sector, such as irrigation and drainage systems and transport networks that connect farmers to inputs and markets (WEF, 2016; Bailey and Wellesley, 2017; FAO, 2018). These same linkages also mean that even when the most direct impact is reduced production, the effects can cascade along the entire agro-food value chain, affecting rural livelihoods, and placing all dimensions of food security and nutrition at risk, particularly in affected areas (FAO, 2021).In addition, these natural hazard-induced disasters can severely disrupt global supply chains, thereby affecting market access, trade, food supply and access, which can in turn reduce incomes, deplete savings and erode livelihoods. In addition, disasters can substantially impact supply chains, even when a disaster occurs in another part of the world. As supply chains are increasingly global, connected and linked, these are thus increasingly exposed to disaster risks (UNISDR, 2012).

Agricultural extension plays a crucial role in boosting agricultural productivity, increasing food security and improving the livelihood security of millions of farmers. Agricultural extension provides critical and technical support services for farming communities to meet the new challenges such as floods, droughts, cyclones etc. confronting agriculture. Although there is well defined agricultural extension service in a country like India, it is observed/stated that agricultural extension systems or machinery face the daunting task of providing the required service to meet the demand before, during and after the disaster strike in preparedness, mitigation and rehabilitation stage of disaster management cycle. Many farmers developed their own strategies and followed indigenous disaster reduction practices to minimize the effect of farm disasters on production but failed because of recurrent and

unpredictable occurrences of disasters with changing magnitude or intensity levels. And thereby farmers are losing their coping capacities with the natural farm disaster. Assessment of the agricultural extension needs of disaster-affected farmers is crucial to develop a holistic extension plan and policies ensuring food and livelihood security for the disaster-ravaged farming community of the country.

Agriculture is the source of livelihood for nearly two-thirds of the population in India. It is predominantly rainfed covering about 60% of the country's net sown area and accounts for 40% of the total food production. Droughts and floods are frequent, and the sector is already facing a high degree of climate variability. The performance of the agriculture sector has a direct bearing on food supplies and food security. India is projected to become the most populated country by 2030 and will need to produce an additional 100 million tonnes of food grains to feed the large population. The agriculture sector is under continuous threat of risks, which are exacerbated by a variety of factors, ranging from frequent natural disasters, climate variability, uncertainties in yields and prices, weak rural infrastructure, imperfect markets and lack of appropriate financial services including design of risk mitigation instruments such as credit and insurance. These factors have a multiplier effect on the farmer's livelihood and income and also undermine the ability of this sector's potential to become a part of the solution to the problem of endemic poverty of the farmers and the agricultural labor (NITI Aayog Report, 2012).

Every year Indian agriculture is being challenged by natural disasters like floods, droughts, hailstorms, pest attacks, etc. The frequency and severity of natural disasters are continuously increasing, and agriculture is affected to a large extent by these disasters since it depends directly on the climate, weather, water and land. Some of the impacts are loss of crops, contamination of water bodies, increased risk of getting disease, destruction of agricultural infrastructures, etc. The agriculture disaster-related challenges are highlighted in Table 1.3

Table 1.3: Disaster Related challenges in Indian Agriculture

Sl. No	Nature of Disaster	Frequency	Intensity
1.	Flood	Regular	High
2.	Drought	Regular	High
3.	Heat waves/Cold waves	Regular	Moderate to high
4.	Pest attack/diseases	Regular	Moderate to high
5.	Hail storms	Regular	Low to moderate
6.	Landslides	Regular	Low
7.	Cyclones	Regular	High
8.	Tsunami	Rare	Moderate to low
9.	Fire	Regular	Moderate to low
10.	Earthquake	Intermittent	Moderate to very high

11.	High intensity rainfall pattern	Regular	High
12.	Lightning and Thunderstorm	Intermittent	Moderate

Source: (NADMP, 2019)

These trends in natural hazard risks and impacts indicate the need for disaster risk management frameworks that build agricultural resilience. A new approach for building agricultural resilience to natural hazard-induced disasters may be a need of an hour. Climate change is increasing the frequency and intensity of natural hazards such as floods, droughts, severe storms, and animal pests and diseases, causing production losses and damaging farmland and assets in agricultural sectors across the world. It is significantly important to protect agriculture from the impacts of disasters as our global food security is dependent on a productive, resilient and sustainable agricultural system. Urgent and ambitious plans and actions are needed to build more resilient agricultural systems as agriculture directly interacts with the environment and natural resources for production supporting the livelihoods of over 2.5 billion people worldwide and contributing significantly to the national socio-economic development. Depending on the projections given by IPCC, weather events are likely to become more severe, intense, and less predictable in the future. Extreme weather events can become a disaster when the society or ecosystems are unable to cope with it effectively (IPCC 2007). The challenge here is to make farming systems and the farmers able to fulfill their goals even in the presence of such random, unpredictable changes, or impacts. In recent years, the concept of resilience has been used increasingly to address such challenges faced by farmers in crop production systems (Tendall et al. 2015). Resilience assessment is needed to improve adaptive capacities for future climate disasters. Community-level assessment of resilience is necessary since stakeholders are heterogeneous (Antwi-Agyei *et.al*.2013), and it helps to understand the social dynamics to develop suitable location-specific adaptation strategies for better implementation.

In disaster-prone regions, building resilience within the agricultural sector has become an urgent priority. Resilience, in this context, refers to the capacity of agricultural systems to absorb shocks, adapt to changing conditions, and continue to provide essential goods and services. Agricultural extension services play a pivotal role in enhancing the resilience of farming communities by equipping them with the knowledge, skills, and resources needed to mitigate and respond to disasters effectively.

To effectively design and deliver extension services that cater to the specific needs of farmers in disaster-prone areas, it is essential to conduct a comprehensive assessment of their disaster risk resilience needs. This research seeks to explore the multifaceted dimensions of disaster

risk resilience in agriculture, identify the unique challenges faced by farmers, and assess the role of agricultural extension services in enhancing resilience. For managing agricultural disasters and developing effective disaster risks reduction strategies and policy framework, a comprehensive and holistic understanding are required of the following researchable key questions such as:

- What is the existing socio-economic profile of the farmers in disaster-prone areas?
- What are the different dimensions and levels of farmers' disaster resilience?
- What are the key determinants of farmer's disaster resilience?
- What are the agricultural extension and risk emergency responses required before, during and after disaster occurrence for enhancing disaster resilience?
- What are the crucial challenges associated with farmers' agricultural extension needs and disaster resilience?

Against this backdrop, the present study entitled "Assessment of Agricultural Extension Needs of Farmers for Disaster Resilience in Dhemaji District of Assam" has been designed with the following delineated specific objectives.

1.1 Specific Objectives of the Study:

- ✓ To study the attributes of farmers in the study area
- ✓ To compute the farmers' disaster resilience and to isolate the factors associated with farmers' disaster resilience
- ✓ To identify the agricultural extension needs of farmers with their associated dimension for disaster resilience
- ✓ To identify the challenges associated with farmers' agricultural extension needs and disaster resilience
- ✓ To construct a strategic paradigm for farmers' agricultural extension needs and disaster resilience

1.2 Need of the Study:

The growing frequency and intensity of disasters, along with the systemic nature of risk are threatening our entire food system. In recent years multiple disasters have imposed devastating consequences on agriculture, food security and the livelihoods of millions of farmers. It is significantly important to protect agriculture from the impacts of disasters as our global food security is dependent on a productive, resilient and sustainable agricultural

system. Extension and advisory services may offer an opportunity for strengthening the resilience of rural and farming communities/households by increasing their access to agricultural inputs, knowledge and skills. In the present global agricultural changing scenario, extension and advisory services must deal with various challenges including natural disasters, climate change adaptation, and rebuilding post-disaster situations. There are major empirical gaps with regard to the role of extension and advisory services in building resilience in farming and rural communities. There is a critical need for understanding the critical role of extension before, during, and after a shock. In a developing country like India, the majority of the people live in rural areas and depend on agriculture for their livelihood. In such a situation building farmer disaster resilience is needed to improve adaptive capacities for future farm disasters and may be the only way to sustain the livelihood security of the farming community and thereby food security for all. In other way studying disaster and farmers' profile of the locality, and challenges of farmers' agricultural extension needs and disaster resilience will enhance the proper farm planning process and appropriate farm contingency plan. Moreover, an emergency extension response system is important and needed to reduce disaster loss and damages. Furthermore, there is a need to undertake empirical analyses to provide specific insights for designing policies and programs that will enable extension services to be more effective and efficient in terms of building the resilience of farming households. For the above reasons, the study was conceptualized to assess the agricultural extension needs of farmers for disaster resilience in Dhemaji district of Assam.

1.3 Limitations of the Study

- Considering the limitations of time and resources of the investigator, only one district in the state of Assam was brought under the purview of the study. Inferences drawn from the study would thus be based on the findings emanating from one district only.
- Since the flood disaster affected farmers were under mental stress it was necessary for a social science researcher to spare a little more time to empathize with their problems and give some mental support to make them comfortable and respond to the questions in a clear and precise way.
- The study included several key independent variables that might influence the dependent variable, but in actual fact, there may be other variables that might influence but were not included within the study because of the limitation of time and resources.

- The responses of the respondents were obtained through a developed research schedule and hence objectivity would be limited to the extent to which respondents were unbiased and truthful in providing desired information.
- The study utilized measuring instruments and scales developed by other researchers and hence the accuracy of these instruments depended on the manner of their development.
- The farmer respondents are often unable to invest enough time to provide deep insights regarding the construct, concept and content of tools prepared for the study

1.4 Organization of Thesis

The dissertation work is organized into several chapters to develop the entire content related to the assessment of agricultural extension needs for farmers' disaster resilience. The first chapter deals with the statement of the problem, specific objectives of the study, need of the study, limitation of the study and limitation of the study and is named "Introduction". The second chapter deals with the different types of literature that were reviewed and directly and indirectly related to the study and is named "Review of Literature". The third chapter is associated with the theories related to the present study and is named "Theoretical Orientation". The fourth chapter deals with the description of the locale of research and is named "Research Setting". The fifth chapter presents the in-depth idea of methods and tools used for the present study and the chapter is named "Research Methodology". The sixth chapter is "Results and Discussion" which depicts the presentation of the results after analysis with tables, graphs and the discussion related to the outcome. The seventh chapter deals with the summarization of the entire thesis content and the recommendation from the outcome for the policy implication and is named "Summary and Conclusion". Other one discussion is incorporated in the thesis in the name of "Future scope of research". The thesis is ended with the "Bibliography" and "Appendix".

CHAPTER-2



REVIEW OF LITERATURE

A review of research findings from previous endeavors, both early and contemporary, aims to gain objective knowledge of the topic under discussion. Past experience sharpens the researcher's efforts and often aids in reducing the loss of key resources such as time and money. A current presentation of the key components of the problem understanding not only provides the empirical investigator with a theoretical foundation but also makes it easier to arrive at a set of practical qualities. As a result, an attempt was made to review the available literature on the current research topic. Where there were gaps in the reviews, some similarly relevant literature was included to fill in the gaps. This chapter deals with the review of relevant literature and research studies done in India and abroad. In order to develop a conceptual framework and appropriate design for the study, some of the available literature relevant to the present study has been reviewed in this chapter under the following heads:

2.1 Conceptual Framework of Disaster Resilience

2.2. Concepts and Significance of Disaster Resilience

2.3 Resilience Measurement

2.4 Disaster Resilience Assessment

2.5. Socio-personal attributes of farmer respondents

2.6 Socio-economic attributes of farmer respondents

2.7 Socio-Psychological attributes of farmer respondents

2.8 Communication attributes of farmer respondents

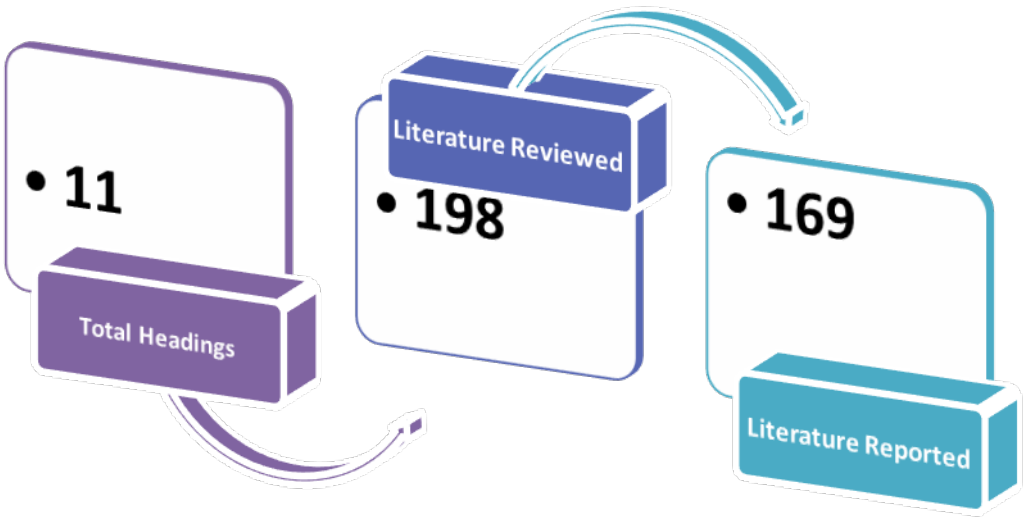
2.9 Factors associated with farmers' disaster resilience

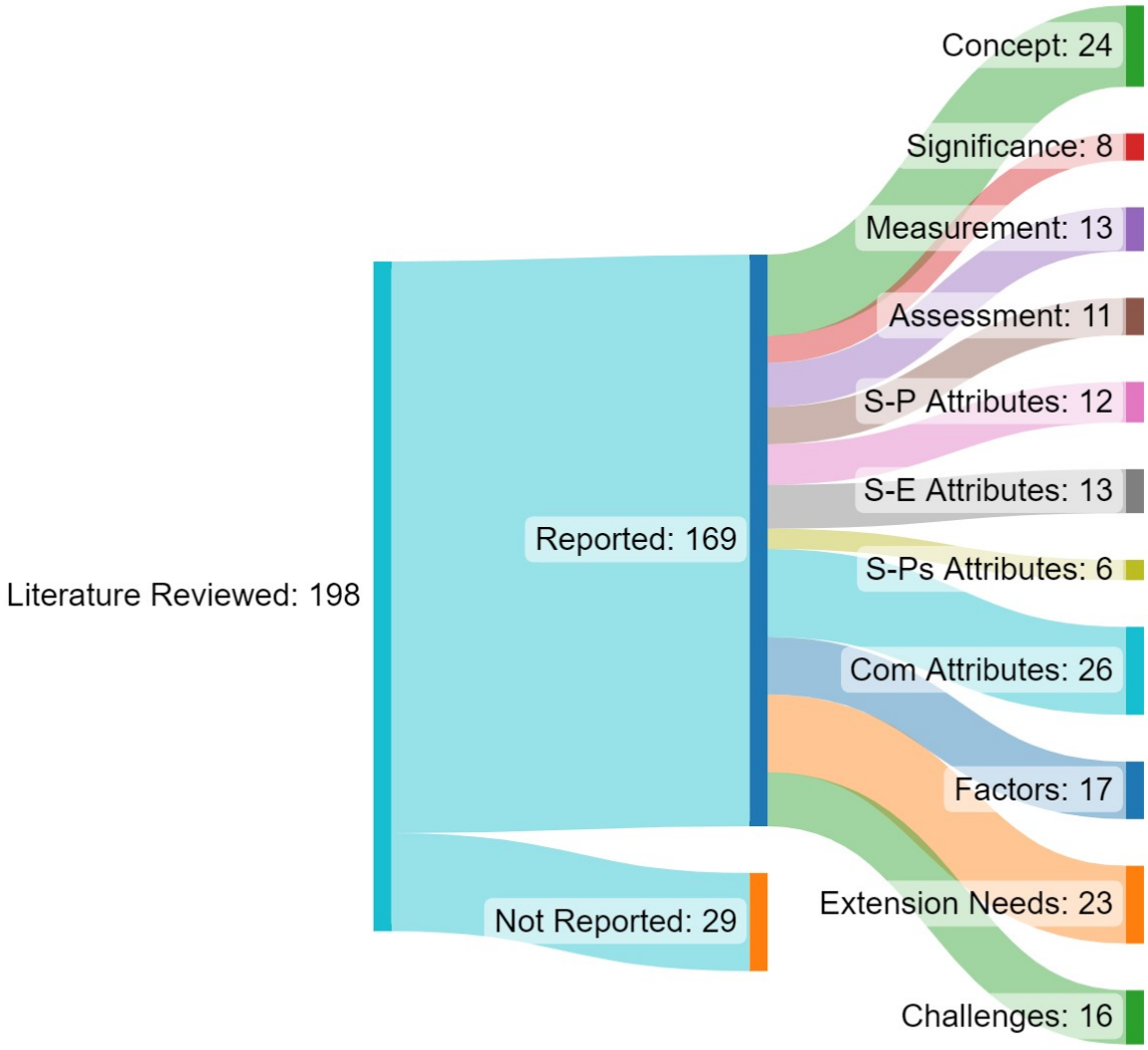
2.10 Agricultural Extension Needs of Farmers for Disaster Resilience

2.11 Challenges of agricultural extension needs and farmers' disaster resilience

2.1: Review of Literature Framework

Headings	Literature Reviewed	Literature Reported
2.1 Conceptual Framework of Disaster Resilience	27	24
2.2. Concepts and Significance of Disaster Resilience	11	08
2.3 Resilience Measurement	17	13
2.4 Disaster Resilience Assessment	13	11
2.5 Socio-personal attributes of farmer respondents	16	12
2.6 Socio-economic attributes of farmer respondents	17	13
2.7 Socio-Psychological attributes of farmer respondents	08	06
2.8 Communication attributes of farmer respondents	31	26
2.9 Factors associated with farmers' disaster resilience	21	17
2.10 Agricultural Extension Needs of Farmers for Disaster Resilience	28	23
2.11 Challenges of agricultural extension needs and farmers' disaster resilience	19	16





2.1 Conceptual Framework of Disaster Resilience

There are a large number of definitions of disaster resilience coined by different studies and reports. These definitions have some commonalities and differences which enabled the scholars to analyze disaster resilience from different perspectives

According to Holling (1973), resilience is a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables

Adger (2000) defined social resilience as the ability of human communities to withstand external shocks to their social infrastructure, such as environmental variability or social, economic and political upheaval

Carpenter *et al*. (2001) social–ecological resilience is interpreted as (1) the amount of disturbance a system can absorb and still remain within the same state or domain of attraction, 2) the degree to which the system is capable of self organization (versus lack of organization, or organization forced by external factors), and (3) the degree to which the system can build and increase the capacity for learning and adaptation.

Resilience is currently defined in the literature as the capacity of a system to absorb disturbance and re-organize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks (Walker *et al*., 2004).

Adger *et al.* (2005) defined resilience as the ability to withstand repeated shocks such as hurricanes or floods through related social-ecological systems in order to maintain critical structures, processes, and feedback

Janssen *et al.* (2006) described resilience as the persistence of relationship in a system to measure the ability and processes to tolerate and persist with changes in the state variables, driving variables, as well as parameters

The Intergovernmental Panel on Climate Change (IPCC) defined resilience as "the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity of self-organisation, and the capacity to adapt to stress and change" (2007).

Twigg (2007) added a new term in the definition of disaster resilience which is "bounce back". Like previous definitions, Twigg also agreed that disaster resilience refers to the capacity of any community to absorb impacts of disastrous events and maintain primary activities, and he also added that a resilient community would not only maintain regular functions during disasters but also will recover and bounce back after the event

Community-level resilience in particular is the response of a community towards an event along with its ability to learn lessons and improve its adaptive capacity (Cutter et al. 2008).

United Nations Office for Disaster Risk Reduction (UNISDR) specifically defined resilience as: "The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions" (UNISDR, 2009).

According to Twigg (2009), community resilience is said to have three phases, namely: (1) capacity to absorb stress or destructive forces through resistance or adaptation, (2) capacity to manage, or maintain certain basic functions and structures, during disastrous events, and (3)

capacity to recover or bounce back after an event. Such efforts taken by stakeholders within a community to address problems at a micro level are very effective rather than a large-scale approach.

According to Cimellaro *et al*. (2010), resilience is characterized as a feature indicating the capacity for a certain building, lifeline systems, bridge, or community to maintain a degree of functionality or performance over a certain period assigned as a control time, generally determined by the owners or the society

Sherrieb et al. (2010) opined resilience as an ability of the group to "bounce back" from extreme stress, including four adjustment capacities: economic growth, social resources, communication facility, and flow information

Pasteur, K (2011) stated that community resilience is seen as the capacity of any community to cope with adverse effects of hazards in an efficient way so that the food security and well-being of the community will not be disturbed

The Department for International Development (DFID,2011), currently known as FCDO, also defined disaster resilience related to the ability of communities and households to face and shocks without compromising future development. But one thing in DFID's definition was that resilience will be achieved through "maintaining and transforming living standards"

According to Laska (2012) "A healthy community is a resilient community, politically, economically, socially, and educationally, to whatever risk arises…"

Asian Development Bank (ADB, 2013) defined resilience as "the ability of countries, communities, business, and individual households to resist, absorb, recover from and reorganize in response to natural hazard events, without jeopardizing their sustained socio-economic advancement and development"

Tanner *et al.* (2014) introduced the concept of livelihood resilience as the capacity of all people across generations to sustain and improve their livelihood opportunities and well-being despite environmental, economic, social, and political disturbances

IPCC defined resilience more broadly as the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation (IPCC, 2014c).

Bergstrand, K (2015) defined community resilience as the ability to cope with, recover from, and adapt to hazards

Brown (2015) defined resilience as capacity to thrive, adapts, and evolves individuals, populations, and processes in the face of stress and shocks, and even change when circumstances need it.

According to Coetzee, C *et al. (*2016), Disaster resilience can be addressed as the capacity of any system or community to absorb impacts of any stress or shock and bounce forward to continue regular activities by reconstructing itself

Qasim, S *et al.* (2016) in their study on Community resilience to flood hazards in Khyber Pukhthunkhwa province of Pakistan defined disaster resilience as the ability of any community or system to face any negative phenomenon and to sustain efficiently with social, economic, environmental, and physical resources. Further they stated that in the context of the community perspective, disaster resilience is the ability of a system to recover from a shock and disaster, which includes the capacities of the community people to absorb and cope with the event

Alam *et al.* (2018) stated resilience was the ability of households or communities to effectively cope with and adapt to hazards in such a way that helps to minimize the loss of life and economic assets

According to Saja *et al.* (2019) resilience was defined as the capacity of organizations to predict, manage and cope effectively with disaster and to undertake recovery actions that reduce disruptions and influence of potential disasters

The Zurich Flood Resilience Alliance (2019) defined resilience as "the ability of a community to pursue its development and growth objectives while managing its flood risk over time in a mutually reinforcing way"

Elmqvist *et al.* (2019) argued that the concept of resilience goes far beyond the mere recovery from disturbances and builds on the adaptive and transformative capacities of subsystems across time and scales

Sarker *et al.* (2020) defined resilience is an ability of an individual, group or community to bounce back from the shocks of sudden risk, threat and uncertainty through utilizing adaptive, absorptive and transformative capacity

Community resilience can be alluded to as the capacity of a local area to use its accessible assets in the administration of unfriendly circumstances and was one of the first concerns of the Sendai Framework for Disaster Risk Reduction (2015–2030).

2.2. Concepts and Significance of Disaster Resilience

Levin, S.A. (1998) stated that "Resilience as the capacity of systems, communities, households or individuals to prevent, mitigate or cope with risk, and recover from shocks".

Alinovi *et al.*, 2010 reported that "FAO has also been testing resilience analysis to assess how households adjust their livelihoods after perturbations".

Adger (2000) stated "resilience as the ability of groups or communities to cope with external stresses and disturbances resulting from social, political and environmental changes"

Ayeb-Karlsson *et al.*, (2015) reported that "in terms of development and climate change adaptation, the concept of resilience provides one of the most promising approaches to poverty reduction, development, growth, and sustainability".

The Paris Agreement emphasizes the importance of fostering resilience as a key goal for addressing both adaptation, and loss and damage. The Sustainable Development Goals (SDGs) are closely linked to resilience building. The Global Climate Risk Index 2019 report concluded that carefully, locally, and inclusively designed adaptation measures can contribute to achieving the SDGs and increasing the resilience of communities (Eckstein et al. 2019). The Sendai Framework on Disaster Risk Reduction includes understanding of disaster risks, strengthening disaster management governance, investing in risk reduction, and resilience building. The SDGs and resilience principles thus offer opportunities for integrative community-based climate change adaptation programs at the grassroots level.

Resilience is the capacity to live and develop with change, and absorb shocks and stresses. Cinner & Barnes (2019) identified six key social domains of resilience and these are:(1) the assets (natural, physical, human, financial) that people can draw upon,(2) the flexibility to change strategies, (3) the ability for social organization to enable (or inhibit) cooperation, collective action, and knowledge sharing,(4) learning to recognize and respond to change,(5) behavioural and cognitive factors (*e.g.,* risk attitudes, personal experience, social norms) that enable or constrain resilience, and(6) the agency to determine whether to change or not.

There are four pillars of resilience that determine the stability and adaptive capacity of households. These are - income and access to food; assets such as land and livestock; social safety nets such as food assistance and social security; and access to basic services such as water, health care and electricity.

Stockholm Resilience Centre has developed seven principles of resilience building that are designed to guide program development and implementation (Stockholm Resilience Centre, 2020).

1. Maintain Diversity and Redundancy.
2. Manage Connectivity.
3. Manage Slow Variables and Feedback.
4. Foster Complex Adaptive System Thinking.
5. Encourage Learning.
6. Broaden Participation.
7. Promote Polycentric Governance.

Building (and measuring) household resilience to food insecurity by definition requires a multidimensional approach.

Pingali *et al*. (2005) stated four principles based on which resilience building strategies are made. These are 1. strengthening diversity; 2. rebuilding local institutions and traditional support networks; 3. reinforcing local knowledge; and 4. building on household ability to adapt and reorganize.

Alinovi *et al.* (2008) emphasized household capacity to resist and absorb a shock. They stated that the ability of a household to adapt to new scenarios depends on the options available to that household to make a living, such as access to assets, income-generating activities, public services, formal and informal social safety nets, institutional environment and resistance capacity. These are ex ante conditions that pre-exist a shock. They fit into two broad categories: a so-termed ecological component (for the basic resources: the natural and human resources a household has at its disposal) and an economic one (for socio-economic and transformative components: the capacity the household has to transform, adapt and create). They further stated that there are five fundamental pillars of resilience. These are 1. Access to basic services; 2. Assets; 3. Social safety nets; 4. Sensitivity; and 5. Adaptive capacity.

2.3 Resilience Measurement

There have been different studies to find proper frameworks to assess community resilience. Saja *et al.* (2019) summarized different frameworks for assessing community resilience. The list includes but is not limited to, Community Disaster Resilience Index (CDRI), Community Disaster Resilience Framework for Iran, Community Resilience Score Card, Conjoint Community Resiliency Assessment Measure (CCRAM), Communities Advancing Resilience Toolkit (CART), Community Disaster Resilience Indicators (CDRI), etc.

Lwin *et al.* (2020) stated that as communities in different areas face various levels of hazards and their capacities are also different, identifying one standard framework for assessing resilience will raise complexity.

Joseph *et al.* (2020) reported that for a long time, community resilience mainly focused on interactions between elements like social, physical, economic, and infrastructural entities.

The Food and Agriculture Organization (FAO) of the United Nations has a long record of experience in this, being the first organization to adopt the concept of resilience in a food security context (Pingali *et al.,* 2005) and in 2008 proposed an econometric approach, the RIMA, for measuring resilience (Alinovi et al., 2008). RIMA was created using the following definition of resilience: "The capacity of a household to bounce back to a previous level of well-being (for instance food security) after a shock". RIMA estimates household resilience to food insecurity with a quantitative approach to establish a cause effect relationship between resilience and its critical determinants. Climate Disaster Resilience Index (CDRI) was utilised to measure climate-related disaster resilience by considering five dimensions: physical, social, institutional, economic and natural as resilience level ranging from 1-5, where 1 representing very poor to 5 considered as best.

Kotzee *et al.* (2016) developed Social-Ecological Flood Resilience Index in Southern Cape of South Africa with the study of "Piloting a social-ecological index for measuring flood resilience: A composite index approach"

Parsons *et al.* (2016) formed Australian Natural Disaster Resilience Framework /Index (ANDRI) against multi hazard with the help of literature review

Yoon (2016) developed Community Disaster Resilience Index (CDRI) for Korea against multi hazard with secondary data

Ostadtaghizadeh *et al.* (2016) developed Community Disaster Resilience Framework for Iran against multi hazard with the help of Expert opinion through Focus Group Discussions while studying the "Community disaster resilience: a qualitative study on Iranian concepts and indicators"

Qasim *et al.* (2016) formulated Social Resilience Index (SRI) (Component Community Resilience Index) in Pakistan against flood with the help of questionnaire and secondary data

Alshehri *et al.,* (2015) developed Community Resilience to Disasters in Saudi Arabia (CRDSA) against multi hazard through Delphi based expert opinion/AHP

Cox and Hamlen (2015) formed Rural Resilience Index (RRI) USA against multi hazard through literature review with the pilot study of "Community disaster resilience and the rural resilience index".

Joerin *et al.* (2014) developed Climate Disaster Resilience Index (CDRI) Chennai, India against Multi hazard through Literature review, CDRI scores

Orencio and Fujii (2013) formed Disaster Resilience Index Japan against Coastal hazards through the study of "A localized disaster-resilience index to assess coastal communities based on an analytic hierarchy process (AHP)Analytic Hierarchy Process (AHP)".

Norris *et al.* (2008) Sherrieb et al. (2012) developed Communities Advancing Resilience Toolkit (CART) USA against multi hazard through Web-based survey using expanded version of the CART

Sherrieb *et al.* (2010) formed Community Resilience Index (CRI) Mississippi counties against multi hazard through Index creation (Archival and population data) while studying "Measuring capacities for community resilience".

Cutter *et al.* (2008) developed Disaster Resilience of Place (DROP) USA against Multi hazard through Conceptual model based on literature review

2.4 Disasters Resilience Assessment

Cutter *et al*. (2008) reported that "there is a considerable research interest in the meaning and measurement of resilience from variety of research perspectives including those from the hazard /disasters and global change communities".

Joerin *et al.* (2014) compared the resilience of two communities in Chennai, India, to climate-related disasters and reported that both the communities have similar exposure to natural hazards (cyclones and river-based floods) due to their close proximity to the sea. While assessing the physical, social and economic resilience of individuals through a Climate-related Disaster Community Resilience Framework (CDCRF), they found that people living in the vicinity of rivers and canals are at higher risk from impacts (damages on house, diseases) of floods compared to others. However, despite their experience to past flood-related disasters, they have not been able to enhance their coping capacity due to their limited adaptive capacity. Thus, their resilience is limited to absorb, manage and bounce back future climate-related disasters (particularly floods)

Neera *et al*. (2019) used a participatory approach for the assessment of resilience and sustainability of hazelnut farming system in central Italy. The results depicted a system with a strong economic and productive role, but which seems to overlook natural resources. This would suggest a relatively low environmental sustainability of the system, although the actual environmental impact of hazelnut farming is controversial. In the study, resilience was assessed with the perceived level of three capacities: robustness, adaptability, and transformability. The results indicated a highly robust system, but with relatively lower adaptability and transformability. The findings also stated that mechanization played a central

role in enhancing past and present system resilience, future improvements can be achieved through collective strategies and system diversification, and by strengthening the local hazelnut value chain.

Villano *et al.* (2019) assessed the resilience of households in responding to climate-induced calamities such as flash floods and landslides in Compostela Valley of the Philippines. using cross-sectional survey data and applied the integrated data envelopment analysis (DEA)-based network model to estimate a composite resilience score, ranging from zero to one, and decomposed into coping and adaptive capacities. They found that overall resilience score of households is, on average, 0.75, while the average coping and adaptive capacity scores are 0.61 and 0.92, respectively. The study further stated that correlation of the overall resilience with the adaptive capacity is significantly higher than that of the overall resilience and the coping capacity. The findings of study also indicated that adaptation measures of households mainly depend on external assistance that enables vulnerable households to recover from calamity, and thus effectively achieve post-event life stabilization.

Meuwissen *et al*. (2019) developed a framework to assess the resilience of farming systems, and presented a methodology to operationalize the framework with a view to Europe's diverse farming systems. The frame work is designed to assess resilience to specific challenges (specified resilience) as well as a farming system's capacity to deal with the unknown, uncertainty and surprise (general resilience). The framework provides a heuristic to analyze system properties, challenges (shocks, long-term stresses), and indicators to measure the performance of system functions, resilience capacities and resilience-enhancing attributes. The study revealed a relatively low capacity of this farming system to transform and farmers feeling distressed about transformation, while other members of their households have experienced many examples of transformation.

Song *et al*., (2020) used eight evaluation indices from four aspects such as technology, economy, environment and society to build the resilience model of agricultural system under flood disaster. The study adopted he TOPSIS based assessment model to assess the resilience of agricultural system under flood and water logging disasters and assessment results were found to be consistent with the actual situations

Barua *et al*. (2020) found in their study 'Resilience of agriculture farmers for crop production in responses to climate change impact on south-eastern coast of Bangladesh' that there is a trend of temperature rise and erratic rainfall. Further the participants of the study stated that the current climate in the study area behaving differently than in the past on a number of

climate risk factors like increased temperature, frequent drought, changes in seasonal rainfall pattern, long dry spells, increase of soil salinity, increase of tidal surges affecting crop production. The study also revealed that the main reasons of yield reduction (20-40 % yield loss) in T. aman crop are erratic rainfall, increased intensity and frequency of drought, salinity, floods, cyclone, use of local varieties, increased incidences of pests & diseases etc in the context of climate change. The study also identified sorjan system of cropping, rice-fish dual culture, utilization of bunds as vegetables/spices production in *gher* areas, floating bed agriculture and homestead gardening with introduction of salt-tolerant & drought tolerant crop varieties as potential adaptation options for development of coastal agriculture for sustainable agricultural production .

Chisty *et al*. (2021) found in their study entitled Assessing Community Disaster Resilience in Flood-Prone Areas of Bangladesh: From a Gender Lens that that female members of the community lag in terms of disaster resilience comparing to their male counterparts. The scores in different components of resilience assessment framework indicated that there are gaps in terms of level of resilience from the gender perspective. The same disaster can create a disproportionate level of impact on women and men due to an unequal level of resilience. The study concluded that assessing community disaster resilience and introducing resilience enhancement interventions should focus on a gender-based approach.

Jayadas and Ambujam (2021) assessed the resilience in two farming communities in Tamilnadu State thorough Farmer Resilience Index and they reported that farmers from both communities have below-average physical resilience which implies that farming households take few actions to improve their resilience since most of the extensions services and support are provided by governmental authorities. The study also stated that farmers with lesser exposure to climate extremes have fewer disaster experiences and take a longer time to improve their resilience. Their ability to absorb and overcome shocks from disasters is gradual but certain when they constantly equip themselves with knowledge about climate extremes and their adaptation measures. Further the study revealed that farmers in the village away from the coast have involved themselves in a non-governmental-based farmer organization which has made them comparatively more aware of resilience improvement strategies attributing to their higher Social Resilience Index value than the village on the coast. It was found that landholdings are also associated with the economic status of the farmers in a community. Large/medium farmers have mobile phones with internet facilities unlike their counterparts (small/marginal farmers), thus increasing their capacity to deal with

climate-related disasters. Agriculture itself is highly sensitive to any changes in climate, and hence, it is of utmost importance to improve the adaptive capacities of the farming communities

Spiegela *et al.* (2021) investigated how European farmers perceive resilience capacities (robustness, adaptability, and transformability) of their farms and findings indicated that the perceptions of robustness, adaptability, and transformability are mutually dependent. The study also found that farmers who perceive their resilience above the regional averages are characterised by lower risk aversion, greater focus on providing public goods, a higher number of implemented risk management strategies, more active involvement in networks, and greater openness to innovation.

Wassie *et al.* (2023) in their study on "Agricultural livelihood resilience in the face of recurring droughts: Empirical evidence from northeast Ethiopia", found that about 57% of the surveyed respondents were non-resilient, while 43% were resilient to different degrees. In the study the Livelihood Resilience Index (LRI), framed on absorptive, adaptive, and transformative capacities, was used to quantify the households' livelihood resilience. The study further indicated that Abay Tekeze watershed (ATW) livelihood zone exhibits the highest proportion of resilient households (57.4%), while North Wollo highland belg has the lowest proportion (22.7%). The high resilience in ATW was attributed to the relatively lower persistence of droughts, better accessibility in enabling institutions, more access to agricultural inputs, and the training and support given to farmers. The better-off were more resilient (90.9%) than the medium (52.1%) and the poor (34.6%) households.

2.5 Socio-Personal Profile of the Farmers

Anonymous[1] (2009) in his report on " live better with the flood" – an approach for sustainable livelihood security in Dhemaji district of Assam reported that nearly 25.70 percent of the respondents in the selected farms belonged to the age group of 19-30 years and 28.00 percent belongs to 31-40 years in all the clusters.

Pawar (2010) found that "majority (65.89%) of the farmers from middle age group i.e. 34 - 57 years and highest 45.24 per cent of farmers were having secondary level of education in Sangli district of Maharashtra".

Sasane *et al.* (2010) carried out a study in Kolhapur district of Maharashtra and found that "majority (41.67 per cent) of farmers belong to the old age group of above 56 years followed by middle age group and young age group as 36.66 and 21.67 per cent, respectively".

Singh *et al.* (2010) found that the "socio-personal attributes of the farmers like education,

caste established positive and significant relationship with their extension contact as well as mass media exposure. Social participation of the farmers found to be establishing no significant relationship with their extension contact but observed positively and significantly correlated with their media exposure, other attributes of farmers like age, family size, family type and occupation found no significant relationship with their extension contact and mass media exposure both".

Naberia *et al.* (2011) reported that "socio-personal attributes of the farmers such as age, caste, education, family type and family size, land holding, occupation, annual income, social participation were positively and significantly correlated with the adoption of low-cost technologies taken under MAPWA programme".

Mohapatra and Sahu (2012) revealed that "majority 75.56 percent of the respondents belonged to average family size with 5-10 members, 13.33 percent of the respondents had large size family comprising of more than 10 members. Thus only 11.11 percent of the respondents had small family size of up to 4 members".

Singh and Sadangi (2012) reported that "family size of 5-6 members was found to an extent of 39.58 percent".

Khatun and Roy (2012) reported that "relationship between livelihood diversification and education has a positive relationship".

Kakoty (2013) in her study on livelihood opportunities of Rural Youths in Dhemaji District of Assam, reported that "majority of the respondents belonged to the group of 33-35 years group(27.00%), which was followed by 21.00 percent of respondents belonging to 30-32 years of age group".

Das (2014) found that "attributes of the farmers like age, education, household type, household size and caste having significant impact on adoption of ICT sources".

Kalel (2014) reported that "average size of family as 4.54, majority (33.92%) of farm families were educated up to high school followed by 33.04 per cent were having up to primary level of education".

Doley (2015) revealed that "42.50 per cent respondents belonged to the age group 36-50 years having educational qualification mainly up to HSLC level (22.50%)".

Umar *et al.* (2015) found that "education and farming experience establishing positive and significant relationship while age was having negative and significant relationship between satisfaction levels of farm families".

Borosa (2016) revealed that "majority of the respondents (80%) belonged to 25-29 years of age having educational qualification up to high school level (35.33%)".

Chen and Lu (2019) reported that "variables like gender, age, education level and marital status of the farmers were significantly correlated with their information needs at 1% level of significance".

2.6 Socio-Economic Profile of the Farmers

Barrett *et al*. (2001) found that for non-farm income diversification and rural livelihood, various assets like financial savings, skills, education, social contacts acted like a stimuli that encourage the rural people to take advantage of the emerging market opportunities.

Anand (2007) reported that "half of the farmers (50%) belong to marginal category of land holding followed by the small farmers 38 percent , medium farmers (8.67) and large farmers (3.33%)".

In the study of Adhiguru *et al.* (2009), it was revealed that "less information was available to small and marginal farmers from less number of sources than medium to large farmers".

Singh *et al.* (2010) found that "attributes namely landholding, material possession and annual income of the farmers had positive and significant relationship with their extension contact and mass media exposure".

Pawar (2010) observed that "71.14 per cent of farmers had medium annual income (Rs.92,552 to 2,44,825) followed by 16.28 per cent and 12.58 per cent had high (Rs.2,44,826 and above) and low (up to Rs.92,551) income respectively, while 64.38 per cent of farmers had medium (2.01 to 4 ha) size of land holding, while 25.90 per cent had big size of land holding (above 4.01 ha)".

Naberia *et al.* (2011) reported that "majority of farmers with small landholding were from old age group (46.42%), 35 per cent illiterate and 25 per cent having middle school level of education, no membership in any organization (60.71%) and low income (59.28%) in Katni district of Madhya Pradesh whereas, farmers with medium land holding were mostly from middle age group (70%), with 26 per cent illiterate and 24 per cent had high school level of education, graduate and above (28%), had membership of more than one organization (59%) and medium annual income (74%)".

Sharma (2012) reported that "a large majority of the respondents (96.66%) were marginal land holders and had a minimum land holdings at less than 1 ha (7.5 bighas) of their own and some of them were completely landless".

Singh (2012) observed that "states with higher share of marginal and small farmers and

higher share of rainfed area are positively correlated with share of rural population below poverty line and higher score of State Hunger Index".

Singh and Singh (2012) reported "that 53.33 per cent of farmers had moderate socio-economic status, with remaining 30 per cent having a low and 16.67 per cent having a high economic status".

Barman *et al.* (2013) found that "more than 70% respondents belonged to marginal farmers and the rest belonged to small and medium farmers".

Mittal and Mehar (2013) observed "land positively significant with all information sources i.e. face-to-face, other farmers, traditional media and modern ICT".

Chand *et al.* (2015) reported that "income earned from farming by 53 per cent famers, who operate on land holdings below 0.63 hectare, was not enough even to keep them above poverty line".

Umar *et al.* (2015) found that "farm income and farm size of farm families had no relationship with their level of satisfaction".

Chanana (2016) reported that "economic condition of farmers after green revolution has improved to some extent but did not last longer".

Chand (2017) reported that "22.5 per cent of households in India had income less than that of poverty line and in Maharashtra it was 18.9 per cent".

2.7 Socio-Psychological profile of the Farmers

Choudhary (1997) found that 68.33 per cent of farmers had medium economic motivation followed by 16.67 per cent and 15.00 per cent under low and high economic motivation respectively.

Reddy (1997) found that 48.00 per cent of the diversified farmers had medium economic motivation followed by low (32.67%) and high (19.33%) economic motivation, respectively.

Reddy Gurava (1998) found that majority of farmers (76.67%) had medium economic motivation was followed by low (15.83%) and high (7.50%) levels of economic motivation.

Dutta (1998) revealed that majority of the respondents (82.32%) had medium level of risk preference followed by low and high level of risk preference (12.16% and 5.52% respectively).

Natikar (2001) found that 67.50 percent of the subscriber farmers belonged to high risk orientation category followed by medium risk orientation (16.86%) and low risk orientation (15.63%) categories.

Shashidhar (2003) reported that an equal percent of respondents had low 36.67 percent and high (35.50%) risk orientation and the remaining 27.78 percent possessed medium risk orientation. From the above studies it can be concluded that, majority of the farmers had medium risk bearing capacity.

2.8 Communicational Profile of Farmers

Yahaya (1995) revealed that "radio is the most potent source of information for farmers and farmers' companions".

Starasts (2004) found that "characteristics of a good source of information include applicability, timeliness, precision, cost efficiency, total accessibility, consistency and aggregation".

Ratan *et al.* (2005) pointed that "even in agriculturally backward states like Jharkhand a majority of the semi-modern tribal women (90%) were found using radio, television and film to get information on improved technology of rice production, viz. varieties, nursery management and transplantation".

Prathap and Ponnusamy (2006) reported that "traditional media have a slight edge over new media in terms of influencing knowledge gain and television is most effective treatment, followed by newspaper, internet and radio".

According to Burman (2008), "Information and Communication Technologies (ICTs) is able to play a significant role for providing information to the farming community at a reasonable cost and reporting farmers' feedback to the research system for improving the quality, timeliness and reliability of Information".

The report of Adhiguru *et al.* (2009) on the flow of agriculture information disclosed "that 40 per cent of farm households have access to information from one source or the other.

Boz and Ozcatalbas (2010) described that "essential sources of information for farmers are input suppliers, mass media, family members and neighbour farmers".

Halakatti *et al.* (2010) found that "television was most used followed by radio and print media".

Mittal *et al.* (2010) found that "a number of non-mobile accessible sources of information are available for most of the farmers to search for daily agricultural information".

Pawar (2010) observed that "newspaper as printed media was used by majority (73.36%) of the farmers, television as electronic media was used by 65.12 per cent; assistants of Agricultural Department as formal personal source was used by 41.44 percent and

progressive farmers as informal source of information was used by 57.82 per cent of the farmers in Sangli district of Maharashtra".

Ogboma (2010) reported that "farmers may have information or knowledge from their personal experience, workshops, seminars, training, friends and neighbours, Ministry and Departments of Agriculture, agriculture publications, extension personnel, local public or private representatives, NGOs, agriculture libraries, exhibitions etc".

Hanumanaikar *et al.* (2011) reported that "majority of the farmers in Karnataka state read farm magazines with frequency as occasionally (63.33%) and regularly (15%)".

Yadav *et al.* (2011) mentioned that progressive farmers were the most accessed personal localite information source for all farmer category i.e. big farmers (84.85%), small (81.77%) and marginal (80.05%) followed by family members and neighbours".

Babu *et al.* (2011) found that" input dealers were the prime source of information for farmers at the time of facing crisis during the production period".

Jaisridhar *et al.* (2012) claimed that the "IT-based custom agricultural extension system called e-sagu offers an agri-advisory platform to the next generation on time and personally".

Mittal (2012) mentioned that" informal networks consider face-to-face interactions with fellow farmers, friends, relatives and extension agents".

Bachhav (2012) stated that "colleagues or fellow farmers following the newspapers and government office are the first-choice information sources for farm families".

According to Ferroni and Zhou (2012), "input dealers and progressive farmers are on prime call for many farmers, than the public institutions like KVKs in all over the India".

Lahiri and Mukhopadhyay (2012) stated that "farmers mostly preferred farm information is regarding technology transfer, rural development, agricultural marketing and weather forecast".

Mittal (2012) stated that "along with utilization of the public extension services for information, farmers access use to variety of other information sources too".

Babu *et al.* (2013) stated that "to satisfy the information needs of the farmers', the availability and timeliness of relevant information is needed".

Ganesan *et al.* (2013), revealed that "farmers use the agricultural mobile multimedia advisory system irrespective of socioeconomic characteristics".

Mittal and Mehar (2013) found that "more than 90 per cent of farmers found accessing information from other farmers".

Mtega and Benard (2013) reported the "several sources of that farmers use to avail for farming information, which were magazines, newspapers, press releases, community leaders, and famer groups).

Sharma (2014) revealed that "elders or family members (84.25%) and friends or relatives or neighbours (52.25%) are most commonly used by the farmers for information in Sagar district of Madhya Pradesh".

Chatterjee and Nath (2015) stated that "progress in internet technologies had greater impact on rural lives and rural areas".

Haldar *et al.* (2016) exposed that "networks of seed and planting materials and fertilizer and plant protection were identical and had same actors at core".

Kamani *et al.* (2016) stated that "social media is very capable of helping small-scale farmers to access and exchange information".

Sangada *et al.* (2016), reported that "a good communication source influences the adoption process directly".

Ali *et al.* (2018) stated that "farmers could obtain limited information on the use of ICTs for disaster-related purposes from extension staff".

Aram *et al.* (2018) reported that "mobile advisory services (MAS) have increased farmers ' expertise in plant management, the new agricultural technology, government schemes and entitlements related to farming, post-harvest techniques as well as cattle care and management".

Vidanapathirana (2019) stated that "establishment of information centres at village level are needed for easy and effective use of agricultural information in this digital age".

Benard *et al.* (2014) revealed that "relatives or friends, personal experience, neighbours, and extension officers are the key information sources used by the farmers".

Rastogi and Hasan (2014) reported that the neighbours or family members (61.25%) were most preferred personal localite communication source followed by local agricultural input dealers (13.75%)".

Kumbhare *et al.* (2015) revealed that "majority (52.67%) of the respondents were the daily listeners of community radio programmes followed by 30 per cent weekly listeners and 17.33 per cent fortnightly listeners".

Adio *et al.* (2016) reported that "relatives (89%) and film shows (82%) were the adequate information sources available to the farmers at local level and the sources like conferences

and workshops, extension workers or agent and contact, television, non-government organization (NGOs) and mobile phones were not inadequately available".

Patil *et al.* (2016) "revealed that majority of the respondents have utilized personal localite sources of information to medium extent (51.39%) and personal cosmopolite sources of information to low extent (65.28%)".

Karn and Ghosh (2018) found that "mass media information sources like *krishi mela* or exhibition and mobile phone; personal cosmopolite information sources like input supplier and co-operatives; personal localite sources like friends or neighbours or relatives and experienced or progressive farmers were the top most information sources preferred by the farmers".

2.9 Factors associated with farmers' disaster resilience

Folke *et al.* (2003) identified four clusters of identifiable factors that help build resilience in social–ecological systems: (i) learning to live with change and uncertainty – such as learning from crisis and developing coping strategies; (ii) nurturing diversity in its various forms – such as nurturing a diversity of institutions to respond to change and creating political space for experimentation; (iii) combining different types of knowledge for learning – such as building capacity to monitor environmental or climate conditions and recognizing the value of local experience in resource management and (iv) creating opportunity for self-organization and cross scale links – such as creating multilevel planning or monitoring systems and building capacity for self-organization.

Allison & Horemans, (2006) applied a framework following sustainable livelihoods criteria in coastal zones through the lens of disaster risk reduction and identified eight factors that contribute to resilience based on a comparison of pre- and post-shock livelihoods. These are governance; socioeconomic diversification; natural resource management; land-use planning and structural design; risk knowledge; warning and evacuation; emergency response and disaster recovery planning

Bahadur *et al.* (2013) identified ten characteristics of resilience based on literature related to society, ecology and social-ecological systems. These are High diversity; Effective governance and institutions; Acceptance of uncertainty and change; Non-equilibrium system dynamics; Community involvement and inclusion of local knowledge; Preparedness and planning; High degree of equity; Social capital, values and structures; Learning; Adoption of a cross-scalar perspective

Norris and Batie (1987) reported that "higher level of education is believed to be associated with access to information on improved technologies and higher productivity to cope up with climate change".

Kebede *et al. (*1990) reported that "there is a positive association with number of years of experience in agriculture and the adaptation of improved agricultural technologies in order sustain under changing climate".

Igoden *et al.* (1990) observed that "there is a positive relationship between the education level of the household head and the adoption of improved technologies and adaptation to climate change".

Feder and Umali (1993) reported that "it is often found that aged farmers are less likely to adapt soil conservation practices because of their shorter planning horizons and a less than perfect capitalization of such benefits because of underdeveloped land markets".

Pomp and Burger (1995) stated "adaptations by more educated individuals are more likely to influence others".

Schuck *et al.* (2002) found that land tenure issues may limit the effectiveness of extension education in Cameroon. They examine the extent to which extension education can promote adaptation of cropping systems other than slash and burn, and whether or not land tenure issues reduce the effectiveness of extension education. Their results indicate that higher visit by extension personnel reduce the likelihood of farmers choosing slash and burn agriculture, but farmers with lower levels of land ownership are less likely to adapt alternatives than those with higher levels of land ownership under changing climatic condition.

David (2007) found that by using Heckman's sample selectivity probit model reveals that although experienced farmers are more likely to perceive climate change, it is educated farmers who are more likely to respond by making at least one adaptation. In terms of policy implications it appears that improved farmers education would hasten adaptation. The provision of free extension advice may also play a role in promoting adaptation. In so far as distance to the market is a significant determinant of whether a farmer adapts to climate change, it may be that improved transport links would improve adaptation.

Yirga (2007) reported that "households with large families may be forced to divert part of the labour force to off-farm activities in an attempt to earn income in order to ease the consumption pressure imposed by a large family during aberrant weather condition".

Annand (2007) stated that "among the personal, socio-economic and psychological factors, age, family size, land holding, technology utilization and economic motivation were found significant at 1 percent level of probability with sustainable rural livelihoods".

Shankara (2010) reported that "variables viz., age, education, family size, farming experience, income, land holding, innovative proneness and extension agency contact had a positive significant relationship with the farmers' perception of climate change".

Barnes & Toma (2012) observed that strategic investments in agriculture are often lumpy and irreversible, with significant impacts on fixed costs. The implication is that large mechanized farms will probably be the first to adapt to climate change.

Deressa *et al.* (2011) in their study reported that "farmers' perception of climate change was significantly associated to the age of the head of the household, wealth, knowledge of climate change".

Preethi(2012) revealed that "mass-media exposure, farming experience and irrigation potential had a positive significant association at 5 per cent level whereas, age, education, family size, land holdings, cosmopoliteness, extension participation, material possession, and scientific orientation were non-significant with the knowledge level of non- agro-met advisory service (AAS)farmers towards climate change".

Lalitha (2016) observed that "there was positive and significant relationship between education, annual income, cropping intensity, irrigation potential, risk orientation, scientific orientation and perception of farmers on climate change with agro bio-diversity".

Murthy *et al*. (2019) reported that "variables like mass media exposure, economic motivation, distance to market, innovative proneness ,education, irrigation potential, risk orientation and extent of natural capital had highly significant association with climate resilient management level of farmers".

2.10 Agricultural Extension Needs of Farmers for Disaster Resilience

Etling and Smith (1994) reported that "participation of local farmers and villagers is essential to identifying their needs accurately followed by securing commitment for successful planning and implementation of development projects".

Klair *et al.* (1998) stated that "information needs of farmers are evolving from time to time as farming technology is changing, climate changes are taking place, agricultural policies are developing and farming innovations are emerging".

Wesseler and Brinkman (2002) reported that "about 75 per cent of the farmers are interested in information on soil and land management and 67 per cent are interested in information related to agricultural and rural credit".

Meera *et al.* (2004) revealed that "top most needs perceived by Gyandoot farmers were about market information (90%) followed by online access to land records and registration (82.50%), question and answer service (67.50%), information on rural development programmes and/or subsidies (57.50%) and weather forecasting (47.50%)".

Adebayo (2006) stated that "information is an important factor in the development process and agricultural information is central in enhancement of agricultural productivity and poverty reduction among rural farmers".

Tologbonse *et al.* (2008) stated that "most of the rice farmers (89.9%) need crop production information".

Adhiguru *et al.* (2009) revealed that "most farmers (32-55%) have pursued information regarding seed followed by fertilization application (24-41%) and plant protection in the cultivation sector (14-18%)".

The study conducted by Meitei and Devi (2009), reiterated that "information needs perceived by farmers for agriculture was noted as 80.61 per cent, where, information on variety of seeds, pesticides, fertilizer, weather condition, irrigation, harvest, post harvest technology were found to be perceived highest by majority of farmers from hill (23.71%) and valley (21.92%)".

Saravan *et al.* (2009) revealed that "farmers need information mostly on pest and disease management".

Glendenning *et al.* (2010) pointed that the "majority of farmers in India have no access to any source of information even after multiple numbers of agencies engaged in extension approaches".

Swanson and Rajalahti (2010) concluded that "use of a well-organized extension system including traditional and modern methods of communication like television, radio and mobile phones could met local information needs; however, internet connection or contact with private firms could met the need of global information".

Chandru *et al.* (2011) reported that "plant protection measures were the most sought information followed by varieties, seed rate, sowing time, weed management, manures and fertilizers and seed treatment".

Shah *et al.* (2011) had concluded that "the farmers' preference has changed toward onion crop in spite of irrigation water become scarce, because farmers are noticed to prefer early returns on their investment".

Babu *et al.* (2011) found that "best sowing time, method of planting, control of pest and disease, application of pesticides and fertilizer, storage and processing of seed as the important information needs of the farmers".

The study of Bachhav (2012) revealed that "many farmers need information regarding seed availability (74.29%) followed by crop production (70.86%), availability of fertilizers (64.58%) and insecticide availability (62.29%)".

Chand (2012) stated that "agriculture development in India highly depends on effectiveness of the public agriculture extension, its approaches, service delivery, methodology and processes".

Ferroni and Zhou (2012) stated that "information on prices and markets, post-harvest management, produce quality determinants and safety standards are important in the context of farmers needs".

Patil and Rajasab (2012) found that "need for awareness, training programs and active participation of horticulture department are needed for onion growing farmers".

Ganesan *et al.* (2013) stated that information on the control of pests and diseases perceived most important by the majority of the farmers and getting information through cell phone is felt simple and helpful by them".

Menong *et al.* (2013) reported that there are three aspects farmers needs mainly agricultural inputs, production and market; and supply chain".

Mittal and Mehar (2013) found that "information needs about input availability (38%) was at top followed by information on pre-sowing activities (23.4%) and very rare need for information on marketing and harvesting i.e. 0.6 per cent and 1.7 per cent, respectively".

Muthiah *et al.* (2013) found that "farmers were more worried about pest and disease management (62%) and best crop cultivation packages (32%) instead of weather and market information (4% and 2%, respectively)".

Sharma *et al.* (2013) reported that "both trainings attended and job commitment were positively and significantly correlated with linkage mechanism used by extension personnel for acquisition of farm technology at 5 per cent level of probability and 1 per cent level of probability, respectively".

Benard *et al.* (2014) reported that "majority of the farmers need information related to marketing (96.3%), weather updates (95%), farm credit or loan (91.25%), new variety seeds (88.7%), method of storage (85%), planting methods (83.7%), pest and diseases control (80%) and availability and application of pesticide (77.5%) followed by weed control (68.75%)".

Gedam and Padaria (2014) stated that "extension personnel should use a greater number of information dissemination sources and new communication technologies to address the needs of farmers on time and securing them from distress sale and earning more profit".

Stigter *et al.* (2014) remarked that "agro-meteorological information for farmers via a web site can be limitless, especially if the package is prepared in a collaborative effort with the agricultural experts and farm extension service personnel/agro advisory services, which is the recommended approach".

Singh *et al.* (2015) revealed that "majority (32.91%) of farmers had more concern about source of seeds followed by crop disease and pest management (17.08%)".

Adio *et al.* (2016) reported that "knowing how to store and process raw agricultural produce with new post-harvest technologies (93.8%); to increase productivity, labour force, acquisition of capital and availability of land (92.6%); knowing current market prices for proper profit margin (90.9%) were the top-rated purposes as opined by the farmers".

Vinayagam and Chapke (2016) stated that "farmer needs timely, relevant and reliable information access to support their farm enterprises while facing the problems like climatic changes, increasing scattered and marginalized land for production, limited water availability, increasing use of inputs, rising fuel costs, and unknown market opportunities".

Karn and Ghosh (2017) reported that "information related to land preparation, sowing and transplantation, nutrient management, soil testing, weed management, pest and disease management, etc. were the mostly perceived needs by the farmers".

Lahiri *et al.* (2017) stated that majority (17.32%) advisories on fishery management practices, source of seed (9.95%), livestock management (9.18%), pest and disease management of crops (8.75%), rural development schemes (7.76%) etc were provided by the ICT mediated extension approach".

Sajesh and Padaria (2017) reported that "pest management, pesticide usage, water management, soil fertility, weed management and seed varieties were the most important needs perceived by the farmers".

2.11 Challenges of agricultural extension needs and farmers' disaster resilience

Patel (2004) reported that the "farmers encountered many constraints in getting information about different cultivation practices such as lack of agricultural information centre at district level, lack of information at cooperative societies and lack of prior information about relay/broadcast of relevant programs on TV/Radio".

Haque (2005) found that lack of sufficient information sources, lack of technical support from extension personnel, lack of opportunity to attend agricultural training, non-relevancy of recommended technologies in mass-media, financial problem to gather information items, non-understandability of agricultural programmes in mass-media were the major problems faced by farmers in fulfilling their information needs.

Maddison (2007) opined that "lack of information about weather and climate, lack of knowledge about adaptations, rationing of key inputs including water, lack of appropriate seed, insecure property rights and lack of market access are barrier to adaptation".

Gwimbi (2009) stated that "70 per cent of the cotton farmers faced the barriers to climate change were lack of access to timely weather forecasts, climate change information and credit facilities that were needed to motivate them to engage in water conservation strategies".

Tologbonse *et al.,* (2009) found that "lack of funds to acquire information (54.3%) and language barrier (50.5%) were the major constraints faced by rice farmers in meeting their agricultural information needs".

Shankara (2010) revealed that "major constraints faced by farmers to take up adaptation measures to overcome ill effects of climate change were, high temperature which restrict them to work in the field for longer time, higher cost of the agricultural inputs, non availability of timely inputs (seeds, chemicals, fertilizers etc.), low price for the produce in the market, non availability of labours in the village, higher labour wage and poor supply of uniform electricity (Rank I) were rated as major constraints".

Henry (2011) reported that "majority (87.4 0%) of respondents indicated no access to water as an important barrier to adaptation method".

Ofuokus (2011) reported that "reasons for the failure to adapt to climate change were lack of information (38.93%), lack of money (22.90%), inadequate labour supply (9.92%), inadequate land (17.55%) and lack of potential for irrigation (10.68%)".

Komba and Muchapondwa (2012) observed that the "constraints faced by small holder farmers in Tanzania include lack of funds (25.90%), shortage of water (27.30%), poor planning (7.60%) and shortage of seeds (3.20%)".

Preethi (2012) stated that "lack of technical skills and capacities for adoption of technologies ranked first followed by lack of awareness and sensitization to the development and utilization of new technologies (Rank 2), non availability of timely inputs (Rank 3), lack of information about long term climate change (Rank 4), adoption of new technology costs money (Rank 5), lack of extension services in technology dissemination (Rank 6) and lack of investment capital and land tenure issues (Rank 7) are the major constraints faced by farmers".

Antwi-Agyei *et.al.* (2013) reported that "97.00 per cent of the household perceived that lack of financial resources as a serious barrier to climate adaptation".

Ifeanyi and Issa (2013) observed that "the barriers faced by the cassava farmers in adapting to climate change were land and labour constraints, non - accessibility/ availability of farm inputs, non-availability/high cost of farm facilities, farming practices and traditional belief, information constraints, poor agricultural extension service delivery, income constraints and government non chalet attitude towards climate change issues".

Vinay (2015) revealed that "major constrains faced by farmers to take up management measures to overcome ill effects of climate change were, non availability of labour wage rate (Rank I) followed by Low price for produce in the market (Rank II) this could be due lack of minimum support price fixed by the government".

Lalitha (2016) reported that "difficult to work in the field due to severe temperature obtained higher labour wages and lack of information on causalities of climate change are major constraints faced by farmers"

Kalita (2016) reported that "lack of Awareness about existence of different sources of information was the major constraint faced by the majority of the farmers (63.33%) in meeting their information needs pertaining to climate change adaptation which was ranked first among the constraints, 'lack of awareness and knowledge on impacts of climate change on agriculture' and 'untimeliness of agricultural programme in Radio and TV' were the second and third ranked constraints they faced in meeting their information needs pertaining to climate change adaptation".

Kumar *et al.* (2017) revealed that "farmers faced varied technological, social, psychological and economic constraints while utilizing rice related information".

Raviya (2017) inferred that respondents also faced the constraint on moderate level were: "non availability of information about future aberrant weather conditions including cyclone" with weightage mean score 1.075 followed by "no timely availability of chemical fertilizers

(1.017)", "non-availability of finance in time (0.942)", "high price of organic manures (0.908)", "scarcity of Farm yard manure/Compost fertilizers (0.850)", "lack of knowledge about the new recommended technologies (0.825)", "lack of knowledge to diagnose the pests and diseases in the crop (0.783)" and "not information about radio programmes related to agriculture (0.767)" with rank eleventh, twelfth, thirteenth, fourteenth, fifteenth, sixteenth, seventeenth and eighteenth respectively.

Mahanta (2018) found that 'lack of awareness about existence of different source of information on different aspects of organic tea cultivation' was the most important constraint faced by majority of the respondents (80.00%) which was ranked first. 'Lack of opportunity to participate in training on organic tea cultivation' (75.00%), 'lack of frequent contact with extension personnel/agricultural scientists' (62.00%), "Lack of ICT based agricultural information delivery system' (58.00%) and 'Non relevancy of agricultural programmes in mass media' (50.00%) were the other important constraints faced by them in meeting their information needs which were ranked second, third, fourth and fifth, respectively.

Phiri *et al.* (2018) found that lack of visit by extension officers, lack of rural information centres, lack of finances and lack of mobility were the major challenges faced by smallholder farmers in accessing and using sources of information.

CHAPTER-3



THEORETICAL ORIENTATION

Theoretical orientation is a significant pursuit for a thesis to conceptualize the problem, to get an idea about the theories associated with the whole concept of the topic selected for the research study. The present research study is associated with the idea and theories of assessment of agricultural extension needs for disaster resilience of farmers. This chapter depicts the concepts and theories related to the present research study.

3.1. Disaster Meaning

3.2. National Disaster Risk profile

3.3. National Agricultural Disaster Scenario

3.4. Agriculture risks from the perspective of crop cycle and crop calendar

3.5. Disaster-related Challenges in Agriculture

3.6. Analysis of Sectoral and Departmental Risks and Responsibilities of MoAFW

3.7. Impacts of natural hazard-induced disasters on agriculture

3.8 Key elements of the disaster risk management (DRM) framework for agriculture

3.9 Principles for effective disaster risk management for agricultural resilience

3.10 Resilience and Building Resilience

3.11 Resilience measurement frameworks

3.12 Relationship between adaptation and resilience

3.13 National Agriculture Disaster Management Plan (NADMP)

3.14 National Disaster Management Authority (NDMA)

3.15 Farmers' Information Needs

3.1 Disaster Meaning

A disaster is an event or series of events, which gives rise to casualties and damage or loss of properties, infrastructures, environment, essential services or means of livelihood on such a scale that is beyond the normal capacity of the affected community to cope with. Disaster is also sometimes described as a "catastrophic situation in which the normal pattern of life or eco-system has been disrupted and extra-ordinary emergency interventions are required to save and preserve lives and or the environment".

The Disaster Management Act, of 2005 defines disaster as "a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or man-made causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and

destruction of, property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area".

The United Nations defines a disaster as "the occurrence of sudden or major misfortune which disrupts the basic fabric and normal functioning of the society or community".

3.2 National Disaster Risk Profile

India is vulnerable, in varying degrees, to a large number of natural as well as man-made disasters. Almost 58.6 percent of the landmass is prone to earthquakes of moderate to very high intensity; over 40 million hectares (12 percent of land) is prone to floods and river erosion; of the 7,516 km long coastline, close to 5,700 km is prone to cyclones and tsunamis; 68 percent of the cultivable area is vulnerable to drought and hilly areas are at risk from landslides and avalanches. Moreover, India is also vulnerable to chemical, biological, radiological and nuclear emergencies and other man-made disasters. Disaster risks in India are further compounded by increasing vulnerabilities related to changing demographics and socio-economic conditions, unplanned organization, development within high-risk zones, environmental degradation, climate change, geological hazards, epidemics and pandemics. All these contribute to a situation where disasters seriously threaten India's economy, its populations and sustainable development

India is one of the ten most disaster-prone countries in the world. The country is prone to disasters due to a number of factors; both natural and human-induced, including adverse Geo-climatic conditions, topographic features, environmental degradation, population growth, urbanization, industrialization, non-scientific development practices, etc. The factors, accelerating the intensity and frequency of disasters are responsible for the heavy toll of human lives and disrupting the life support system in the country. As far as the vulnerability to disaster is concerned, the five distinctive regions of the country i.e. Himalayan region, the alluvial plains, the hilly part of the peninsula, and the coastal zone have their own specific problems. While on one hand, the Himalayan region is prone to disasters like earthquakes and landslides, the plain is affected by floods almost every year. The desert part of the country is affected by droughts and famine while the coastal zone is susceptible to cyclones and storms. (http://india.gov.in/india-glance/profile)

3.3 National Agricultural Disaster Scenario

The Indian Government has set a target of doubling farmers' income by the year 2022, a 5 trillion-dollar economy and ease of living by 2024. However, these targets can only be achieved by improving the risk scenario of Indian agriculture and protecting it from natural

disasters through proper adaptation or mitigation. Indian agriculture, like India's landscape, is vulnerable to multiple natural and anthropogenic disasters and is also aggravated by the impact of climate change. The Indian agricultural sector is already threatened by existing stresses such as the limited availability of water resources, land degradation, biodiversity loss and air pollution; Besides, it is one of the most disaster-affected sectors whose activities are adversely affected by weather changes/variations in physical conditions resulting in huge economic losses and disruption of people's livelihood. One of the key drivers behind such increasing economic loss due to disasters is the lack of appropriate disaster management including risk reduction strategy based on knowledge about hazard impacts and access to risk information. The increased frequency and severity of climate-related hazards and risks induced by climate change are adding a new dimension to the existing disaster risk profile of Indian agriculture. Ministry of Agriculture in a recent report in 2018 stated that climate change is projected to impact agricultural productivity with increasing severity from 2020 onwards and could rise as much as 40% by 2100 unless appropriate adaptation measures are undertaken in the agriculture sector. India has diverse agro-climatic regions and as such it is prone to multiple disasters with respect to its zone.

Drought: In a developing country like India, drought has a wide range of effects and its impact (physical, agricultural and socio-economic) is specifically conspicuous in view of the tropical monsoon character of the country. Since agriculture is the backbone of the Indian economy, the impact on agriculture is to be given utmost importance. Indian agriculture largely depends upon monsoon rainfall where about two-thirds of the arable land lack irrigation facilities and is termed as rainfed. The effect is manifested in the shortfalls of agricultural production in drought years (Mohita, 2013). More than 68% of net sown area in India is prone to drought, which varies temporally and spatially. Agriculture drought often leads to a decline in sown area, decreased production, fall in purchasing power, rising unemployment, water scarcity, inflation, widespread malnutrition and spread of diseases. Drought is a complex and least understood natural disaster, the impacts of which often depend upon the nature of the socio-environmental background in the region, and affects more people than any other disaster (Gupta and Sehgal, 2011).

Flood: In addition to drought, flood is another important challenge that affects the agriculture sector. Under the influence of climate change and economic development, the extent of floods is expected to increase (Jonkman and Kelman, 2005; IPCC, 2007). The tangible and intangible losses due to floods in India are increasing due to overpopulation and increased habitation, cultivation and other developmental activities. Indian agriculture has experienced

massive losses like crop losses leading to reduced yields, erosion of top fertile soil, damage to machinery, stored inputs, roads, etc due to floods. Agricultural areas are frequently located in floodplain areas and therefore, this area is particularly targeted. Climate change is also another driver which intensifies the hydrologic cycle thereby increasing the magnitude and frequency of extreme floods. A report stated that land-use issues like decreased natural areas, loss of water bodies, encroachment of rivers/streams and other drainage channels and uncontrolled multiplication of built-up areas, are contributory factors to flood risk (Gupta and Nair, 2011).

Cyclone: All the components of the agriculture sector especially those which are in coastal areas are affected by cyclones through direct damage by high-speed wind, torrential rain and extensive flooding. High tide may also affect agriculture by bringing in saline water and sand mass making the fields unsuitable for agriculture. The indirect effects include pest and disease infestation of crop plants. Agricultural marketing and trade of crop, fish and animal production is adversely affected due to damage of infrastructure. Past cyclones have devastated the crops and resulted in huge monetary losses in the country. The super cyclone in 1999 and Phailin in 2013 severely affected crop production and the livelihood of farmers on the Eastern Coast of India (Rautary et al., 2014). Recently, Cyclone Fani's damage to standing crops was estimated to peg at around 150 crores (Jebaraj, 2019). As such, the Government's support is needed for the recovery of agriculture when such a disaster happens.

Hailstorm: Hailstorm is another natural disaster that is a threat to Indian Agriculture. Hailstorms with powerful winds can physically damage crops across large areas. A small piece of hail can even destroy vegetables like cabbage, lettuce, tomatoes, etc. Thus, farmers suffer huge losses due to this natural disaster (Nag, 2018). Rural households are the ones badly affected by hailstorms especially who are uninsured and potentially unexpected income shocks.

Heat wave / Cold wave: The effect of extremes (heat waves and cold waves) has been rising in India and in the past two years these extremes have increased manifold leading to reduced crop yields. Guleria and Gupta (2016) stated that heat waves affect crop production both quantitatively and qualitatively due to flower drop and higher mortality in new plantations. It is also reported that extreme change in temperature affects the productivity of both Kharif and Rabi crops. Small and marginal farmers are more affected by heat waves and cold waves. The extent of damage caused by cold waves depends on temperature, length of exposure, humidity levels, and the speed at which freezing temperature is reached. It is difficult to predict a definite temperature level up to which crops can tolerate cold waves/frost because

many other factors also affect it. Different crops affected by cold waves in the North in 2006 are shown in Figure.

Pest Infestation: Any harmful organisms that latch onto plants compete for nutrients and render them unsuitable for harvest are pests. Insects constitute the most dangerous pests causing significant damage to agricultural and horticultural crops. Our farmers have been battling pests on the field for ages. When we talk about pests it could be anything that is harming agricultural crops like weeds, insects, mites, rodents, animals and birds. However, the most dangerous of all the pests is insect pests which cause damage to stored products mainly by direct feeding. Some species feed on endosperm causing loss of weight and quality, while other species feed on the germ. Such infestations/damages can be prevented by seed treatment, building healthy soil, planting of resistant variety of crops, row spacing, timely planting, crop diversification and rotation, and spraying natural pesticides. One of the recent pest incidences was the fall armyworm attack on maize (Figure 8) in Karnataka which later invaded crops in more than 9 states. Scientists from the National Rice Research Institute have reported that a rise in temperature and humidity makes a congenial environment for pest growth and development

Post-Harvest Losses: Most often, the post-harvest losses from natural disasters are neglected. It is not only the standing crops that are being destroyed but also harvested crops stored in the silos, agriculture farmhouses, etc. are also affected. Farmers have very poor storage and transportation facilities which becomes more critical for perishable fruits and vegetables. Reports showed that about 34% of fruits, 44.6% of vegetables and 40 of combined fruits and vegetables were unsold in the market (Pandey, 2018). As such, there should be proper and sufficient storage structures where natural disasters cannot affect them and the agro-processing facilities should preferably be located close to the points of production in rural areas.

3.4Agriculture risks from the perspective of crop cycle and crop calendar

1) Seed Selection: The most important step towards getting the best crop yield is seed selection. It should be ensured that good quality seeds are selected based on the cultivation environment. This will ensure in improvement in yield, resistance to pests and insects and drought and an increase in germination rate. Seed selection is also preferably done considering the preferences of the market and therefore, it should also be ensured that high-yielding variety seeds are selected.

2) Land Preparation: Land preparation is done to bring the land to optimum condition for growing crops. Primary and secondary tillage operations are done to pulverize the soil so that

the crops can develop a good root system. Also, a well-prepared land helps in controlling weeds and recycling nutrients. Land preparation is mainly done with tractors or with the help of cattle and buffaloes.

3) Crop Establishment: It includes both direct seeding and transplantation. Depending on the type of crops, seeds are sown directly on the field or transplanted. During this stage, nutrients are also provided so that the plants germinate fast and they don't get wilted.

4) Irrigation: The artificial application of water to land for agricultural production is defined as irrigation. Irrigation is a very important stage in the crop cultivation cycle. Effective irrigation helps in proper germination, root growth and proper utilization of nutrients, etc.

5) Crop growth: After the establishment of crops, the crops are exposed to certain hazards, like pest and insect attacks, attacks by rodents, etc. Plants need to be protected from hazards by taking precautionary measures like using pesticides or insecticides and giving more nutrients. The farmers should adopt proper time, frequency and method for applying fertilizers. Also, for better and faster crop growth, farmers should reduce the density of the crop.

6) Harvesting: The process of cutting the crop and gathering from the field is a very important stage. Depending on the type of crops grown, the time of harvesting also differs. Crops are either harvested manually or using farm equipment/machinery depending upon the type of crops.

7) Post-Harvest Processes: The harvested crops are stored in the storage structures. The storage structures and the time of storage are different from one crop to another. For example, grains are usually dried after harvesting and are stored for a longer duration. However, vegetables and fruits are stored for a shorter period. Other processes like cleaning, milling, packaging, marketing, etc., come under this stage.

The figure below illustrates the process of the crop lifecycle, resources associated with each phase of the crop cycle and related hazards, capable of disrupting the process of the crop cycle.

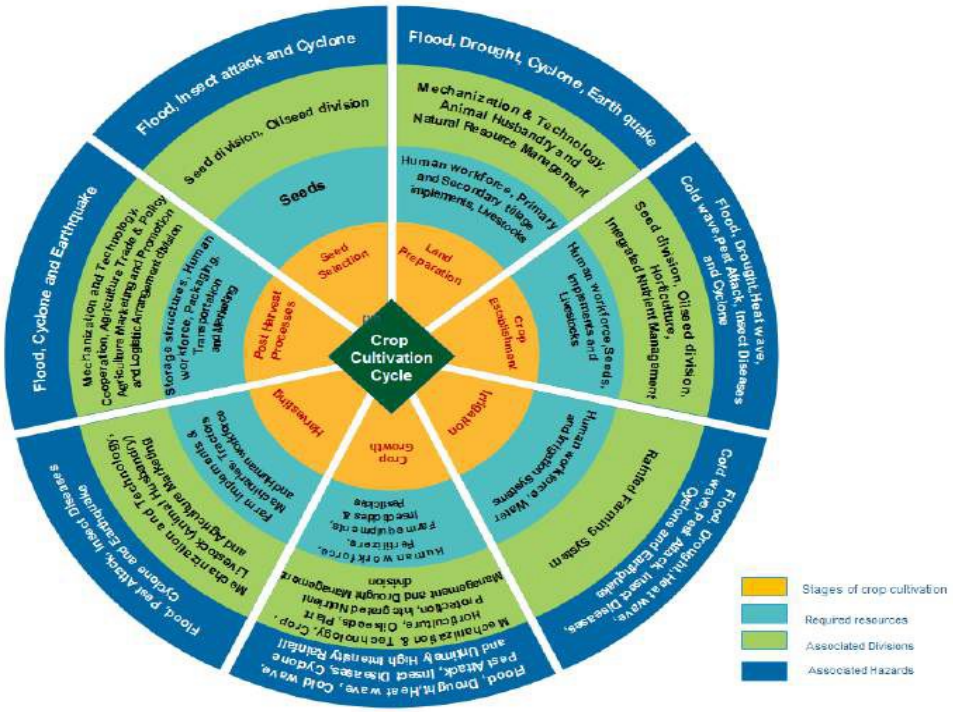


Fig.3.1: Crop cycle and associated Hazards

3.5 Disaster-Related Challenges in Agriculture

Every year, Indian agriculture is being challenged by natural disasters like floods, droughts, hailstorms, pest attacks, etc. The frequency and severity of natural disasters are continuously increasing, and agriculture is affected to a large extent by these disasters since they depend directly on the climate, weather, water and land. Some of the impacts are loss of crops, contamination of water bodies, increased risk of getting disease, destruction of agricultural infrastructures, etc. The agriculture disaster-related challenges are highlighted in Table 3.1.

Table 3.1: Disaster-Related Challenges in Agriculture

Sl. No	Nature of Disaster	Frequency	Intensity
1.	Flood	Regular	High
2.	Drought	Regular	High
3.	Heat waves/Cold waves	Regular	Moderate to high
4.	Pest attack/diseases	Regular	Moderate to high
5.	Hail storms	Regular	Low to moderate
6.	Landslides	Regular	Low
7.	Cyclones	Regular	High
8.	Tsunami	Rare	Moderate to low
9.	Fire	Regular	Moderate to low
10.	Earthquake	Intermittent	Moderate to very high

11.	High intensity rainfall pattern	Regular	High
12.	Lightning and Thunderstorm	Intermittent	Moderate

Source: (NADMP, 2020)

3.6 Analysis of Sectoral and Departmental Risks of MoAFW

The sectoral risks of disasters consist of the risks for the entire sector that the Ministry of Agriculture and Farmers Welfare represents. The departmental risk of disasters consists of the risks arising out of the exposure of vulnerable departmental assets to natural or manmade hazards. An analysis of stages of crop cultivation and the concerned divisions of MoAFW have been shown in Table 3.2. Each stage of the crop cycle is associated with different divisions of the MoAFW.

Table 3.2: Risk associated with different Division of the Ministry of Agriculture and Farmers Welfare

Stages of Crop Cultivation	Required Resources	Related Divisions	Related Hazards
Seed Selection	Seeds	Seed Division, Oilseeds Division	Floods, Insect Attack, Cyclone
Land Preparation	Human workforce, Primary and Secondary Tillage Implements, Live stocks	Mechanization and Technology, Livestock (Animal Husbandry) and Natural Resource Management	Flood, Drought, Cyclone, Earthquake
Crop Establishment	Human workforce, Seeds, Implements and Livestock	Seed Division, Oilseeds, Horticulture Division, Integrated Nutrient Management	Flood, Drought, Heat wave, Cold wave, Pest Attack, Insect Disease, Cyclone
Irrigation	Human workforce, Water and Irrigation systems	Rainfed Farming System	Flood, Drought, Heat wave, Cold wave, Cyclone, Earthquake
Crop Growth	Human Workforce, Fertilizers, Farm Equipment, Insecticides, Pesticides	Mechanization and Technology, Crop Division, Horticulture Division, Oilseeds, Plant Protection, Integrated Nutrient Management, Drought Management	Flood, Drought, Heat wave, Cold wave, Pest Attack, Insect Disease, Cyclone, Untimely High-Intensity Rainfall
Harvesting	Farm Implements and machineries, Tractors, Human Workforce	Mechanization and Technology, Livestock (Animal	Flood, Pest Attack, Insect Disease, Cyclone,

		Husbandry), Agricultural Marketing	Earthquake
Post Harvest Processes	Storage Structures, Human Workforce, Packaging, Transportation and Marketing	Mechanization and Technology, Agriculture Marketing, Cooperation, Agriculture Trade Policy, Promotion and Logistics Development Division	Flood, Cyclone, Earthquake

3.7 Impacts of Natural Hazard-induced Disasters on Agriculture

Natural hazard-induced disasters are a leading cause of food insecurity. The impact of these disasters extends beyond the economic realm – they destroy food, and people's ability to produce, access and intake food, which affects all four dimensions of food security by reducing the availability of food; limiting physical and socio-economic access to food; affecting food utilization, which refers to the body's ability to absorb the nutrients in food that is consumed; and, disasters undermine food stability at all times, as access, availability and utilization of food are disrupted (FAO, 2008). The 2021 edition of FAO's report on *The Impact of disasters and crises on agriculture and food security* revealed that the agricultural sector absorbed between 2008 and 2018, 26% of the overall impacts caused by medium- to large-scale disasters in least-developed countries (LDCs) and in low- and middle-income countries (LMICs). During this period, around USD 108.5 billion was lost alone due to declines in crop and livestock production in LDCs and LMICs as a result of disasters (Figure 2.1). Across all income groups, including in the upper-middle income countries (UMICs) and high-income countries (HICs), loss in crop and livestock production amounted to USD 280 billion.

While the impacts of individual natural hazard events can be severe, natural hazard risk – and indeed, disaster risk more broadly–is becoming increasingly compound and interacting. Droughts and floods can trigger pest and disease outbreaks; weather-related hazards are expected to intensify and increase in frequency because of climate change (IPCC, 2013); and in many countries, natural hazards such as severe storms, droughts and pest outbreaks have compounded the effects of the COVID-19 pandemic on agriculture (FAO, 2021). Interlinkages between agriculture and other sectors and systems also mean that natural hazards can affect agriculture and disrupt farm business activities by interrupting or shutting

down critical infrastructure for the sector, such as irrigation and drainage systems and transport networks that connect farmers to inputs and markets (WEF, 2016; Bailey and Wellesley, 2017; FAO, 2018). These same linkages also mean that even when the most direct impact is reduced production, the effects can cascade along the entire agro-food value chain, affecting rural livelihoods, and placing all dimensions of food security and nutrition at risk, particularly in affected areas (FAO, 2021).

In addition, these natural hazard-induced disasters can severely disrupt global supply chains, thereby affecting market access, trade, food supply and access, which can in turn reduce incomes, deplete savings and erode livelihoods. In addition, disasters can substantially impact supply chains, even when a disaster occurs in another part of the world. As supply chains are increasingly global, connected and linked, these are thus increasingly exposed to disaster risks (UNISDR, 2013).

It is therefore of paramount importance to continue enhancing capacities for disaster resilience in the agriculture sector, across local, sub-national, national and regional levels, and with the active participation of farmers. In these circumstances of natural hazard risks and impacts, there is a need for disaster risk management (DRM) frameworks that build agricultural resilience.

3.8 Key elements of the disaster risk management (DRM) framework for agriculture

In order to reduce disaster risk and increase resilience to disasters, it is important to implement disaster risk management (DRM) actions. The disaster risk management framework considers DRM as a continuum, thus an ongoing process of interrelated actions, which are initiated before, during and after a disaster has occurred. The aim of DRM actions is to strengthen the capacities and resilience of people and communities to protect their lives and livelihoods, by undertaking measures to avoid the creation of new risks (prevention), reduce existing risks and mitigate their impacts (risk reduction/mitigation) and build capacities to be better prepared for response and recovery (preparedness), including the integration of 'building back better' activities with the aim of addressing the root causes of vulnerabilities and risks.

The key elements of the disaster risk management (DRM) framework for agriculture are 1. Disaster risk governance;2. Risk identification, assessment and awareness; 3. Prevention and mitigation; 4. Preparedness for response and recovery; 5. Emergency response; 6. Recovery, rehabilitation and reconstruction. These key elements of the DRM framework directly correspond to the four priorities for action of the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015-2030, which particularly focuses on significantly reducing disaster

risks. Implementing disaster risk reduction measures is key in order to ensure that potential hazardous events will not evolve into disasters.

3.9 Principles for effective disaster risk management for agricultural resilience

Recent and projected trends in natural hazards-induced disasters (NHID) underscore the importance of building agricultural resilience through disaster risk management (DRM) that strengthens the ability of farmers and other agricultural sector stakeholders to prepare and plan for NHID; to absorb, respond to and recover from their impacts; and to more successfully adapt and transform in response to the risk of future NHID. A number of other aspects of DRM are critical for building agricultural sector resilience to NHID, including strong, effective and participatory disaster risk governance, and the importance of *ex-ante* frameworks for disaster response and recovery, including to enable building back better after a disaster. Based on the frameworks, four principles were developed jointly by the OECD and FAO for effective DRM for resilience. The principles are closely aligned with the four Sendai Framework priorities for action and OECD recommendations and propose a menu of actions that governments and agricultural sector stakeholders can take to improve the effectiveness of DRM for resilience in agriculture. Specifically, good practices for effective DRM for resilience in agriculture are identified according to the following four principles:

1. An inclusive, holistic and all-hazards approach to natural disaster risk governance for resilience
2. A shared understanding of natural disaster risk based on the identification, assessment and communication of risk, vulnerability and resilience capacities
3. An *ex-ante* approach to natural disaster risk management
4. An approach emphasizing preparedness and planning for effective crisis management, disaster response, and to "build back better" to increase resilience to future natural hazards

3.10 Resilience and Building Resilience

Resilience can be described as the capacity of systems, communities, households or individuals to prevent, mitigate or cope with risk and recover from shocks. At first approximation, resilience is the opposite of vulnerability. However, resilience adds a time dimension. A system is resilient when it is less vulnerable to shocks across time and can recover from them. Essential to resilience is adaptive capacity. Adaptive capacity encompasses two dimensions: recovery from shocks and response to changes in order to ensure the 'plasticity' of the system. As for vulnerability, resilience can be specified as "resilience of what to what" (Carpenter *et al*., 2001). However, focusing on specified resilience may cause the system to lose resilience in other ways (Cifdaloz *et al.*, 2010). This

is why general resilience can be described as being "about coping with uncertainty in all ways" (Folke et al., 2010). As for vulnerability, resilience can be considered in various dimensions (biophysical, economic and social) and at various scales. The way the various dimensions and scales interact is crucial, precisely because of the importance of general resilience for coping with uncertainty. For instance, studies show that increasing the level of education of farmers can be an efficient means for reducing farmers' household vulnerability to climate change (Karfakis et al., 2011). Resilience puts a greater emphasis on the capacity of a system to recover and transform itself over the long term, and adapt to its changing environment in a dynamic perspective. It implies that it is not only shocks, as a change relative to an average, that have to be considered, but also the change of the average itself.

Resilience is not just with reference to dealing with technical options. It is also about dealing with social situations and challenges. Studying community responses to COVID-19 pandemic, the Global Resilience Partnership, identified the following key social domains of resilience. They are (1) the assets (natural, physical, human, financial) that people can draw upon, (2) the flexibility to change strategies (3) the ability of a social organization to enable (or inhibit) cooperation, collective action, and knowledge sharing (4) learning to recognize and respond to change (5) behavioural and cognitive factors (e.g., risk attitudes, personal experience, social norms) that enable or constrain resilience, and (6) the agency to determine whether to change or not. Lessons learned reveal trust, social networks and community cohesion, collective action, shared learning and community-wide decision-making are the forms of social capital, which are important in determining resilience to shocks and challenges. Resilience puts a greater emphasis on the capacity of a system to recover and transform itself in the long term, to adapt to its changing environment, in a dynamic perspective (https://www.globalresiliencepartnership. org/wp-content/uploads/2021/01/brief_ resilience-of local communities.pdf).

To a great extent increasing resilience can be achieved by reducing vulnerabilities and increasing adaptive capacity. This can be done by reducing exposure to risk, reducing sensitivity and increasing adaptive capacity for every type of risk. It can act in each domain, either biophysical or economic and social. One way to achieve better resilience is to reduce the transmission of shocks between types of risks, between scales and between domains and to organize compensation between scales (for instance transport of feed) or between domains (for instance safety nets) to avoid cumulative and long-term effects. Three ways to build resilience and are reducing exposure, reducing the sensitivity of systems to shocks and increasing adaptive capacity

3.11 Resilience measurement framework

There are many frameworks for measuring disaster resilience. The two most comprehensive and widely –cited frameworks are Twigg's (2009) 'characteristics of resilience' framework and Oxfam GB's (2013) Multidimensional Approach for Measuring Resilience.

Characteristics of a Disaster-Resilient Community (Twigg, 2009) detailed framework outlines a set of 'characteristics' that can be used to measure resilience. It emphasizes the need for organizations working with the characteristics to use the framework as a starting point for identifying and discussing relevant issues, rather than as a 'checklist'. Characteristics should be seen as signposts for indicator development, describing attributes or elements that contribute to the resilience of communities. They then have to be translated into measurable indicators. The framework outlines five thematic areas based on the Hyogo Framework for Action, each of which contains a number of 'components of resilience' In turn, each component of resilience contains more detailed and specific 'characteristics of a disaster-resilient community'. In total, the framework provides a total of five thematic areas; 28 components and 167 characteristics. The five thematic areas are Governance; Risk assessment; Knowledge and education; Risk management and vulnerability reduction; and Disaster preparedness and response.

Oxfam GB's (2013) approach to understanding and measuring resilience is based on five dimensions affecting the ability of households and communities to minimize risks from shocks and adapt to emerging trends and uncertainty.

1. Livelihood viability: The extent to which livelihood strategies can thrive in spite of shocks, stresses and uncertainty.
2. Innovation potential: The ability to take appropriate risks and positively adjust to change
3. Contingency resources and support access: Access to backup resources and appropriate assistance in times of crisis.
4. Integrity of natural and built environment: Health of local ecosystems, soundness of natural resource management practices, and robustness of essential physical infrastructure.
5. Social and institutional capability: Extent formal & informal institutions are able to reduce risk, support positive adaptation, and ensure equitable access to essential services in times of shock/stress.

3.12 Relationship between adaptation and resilience

The following Fig. 3.1 is used to compare resilience and adaptation based on the link between resilience and vulnerability, in which vulnerability can be understood as measures of the

characteristics of a system, namely its exposure and sensitivity to a possible hazard or disaster (Adger 2006). Resilience is the ability to resist and recover from such hazard or disaster in a short interval with minimum to no external support. It is a process that ensues during and post-disaster and helps to improve the abilities of the hazard-affected bodies to resist, to absorb the impacts of climate events, and to bounce back and even improve on their previous status. Adaptation is the process of reducing exposure and vulnerability to a hazard or disaster and to enhance resilience by responding to the disaster risk pre-disaster, and to its loss and impacts during and after the disaster occurrence (Zhou et al. 2010). Thus, reducing vulnerability and improving resilience are the two main objectives of adaptation and it varies with the structure, function, and surroundings of the hazard-affected bodies. Adaptation focuses on the condition of the hazard-affected bodies in the circle of disaster management and supports its sustainability and protection in the future (Zhou et al. 2016). Adaptation is higher than resilience as it could be improved based on social learning (White 1974) and experience and investment from various institutions (UNISDR 2015). Also, adaptation is place-oriented and is the understanding of disaster adaptation for a particular hazard-affected body or place (Zhou et al. 2016).

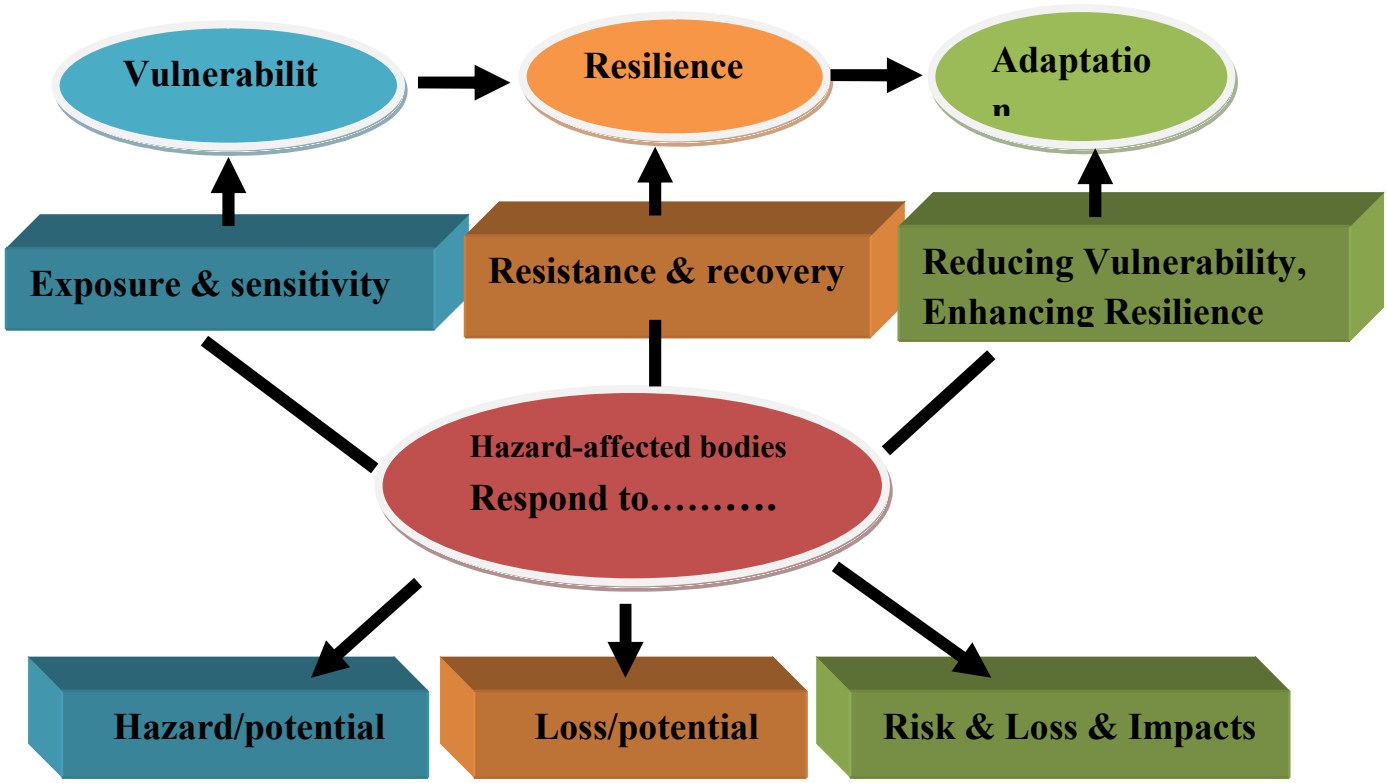


Fig 3.2: The relationship between vulnerability, resilience, and adaptation.
(Source: Zhou et al.,2016)

3.13 National Agriculture Disaster Management Plan (NADMP)

The National Agriculture Disaster Management Plan (NADMP) provides an outline and direction to the Ministry of Agriculture and Farmers Welfare for all phases of the disaster management cycle. It is in accordance with the provisions of the Disaster Management Act 2005. The NADMP is a dynamic syllabus for MoAFW in the sense that it will be periodically updated with the global best practices and knowledge base in disaster management. The basic purpose of NADMP is to guide all the divisions within the department to manage the risks of disasters before, during, and after disasters. These include assessing the risks of disasters, mitigating the existing risks of disasters, preventing the creation of new risks of disasters, and presenting the status of its preparedness to perform its role and responsibilities as defined under the Disaster Management Act 2005 and the National DM Policy 2009.

The specific objectives of NADMP are to facilitate the Agriculture Department in the following:

(i) Assessment of the sectoral and departmental risks;

(ii) Undertake measures for mitigating the existing risks of disasters to the agriculture sector;

(iii) Prevention of the creation of new risks of disasters in the agriculture sector in the state;

(iv) Undertake preparedness measures;

(v) Assigning roles and responsibilities for various tasks to be performed by the department following the Disaster Management Policy and Plan;

(vi) Undertake measures proposed for strengthening capacity-building and preparedness of farmers and other stakeholders of the agriculture sector;

(vii) Facilitate coordinated response at various levels.

The NADMP has been aligned broadly with the goals and priorities set out in the SDGs, Paris Agreement on Climate Change and Sendai Framework for Disaster Risk Reduction (SFDRR). The NADMP incorporates an integrated approach towards Disaster-related plans, viz. Manual for Drought Management, Drought Management Plan, Crop Contingency Plans prepared by CRIDA, Disaster Management Plan of Dept. of Animal Husbandry, Drought Proofing Plans, Relief Manual, National Initiative on Climate Resilient Agriculture(NICRA), National Mission for Sustainable Agriculture (NMSA), India Nationally Determined Contribution (NDCs), guidelines prepared by NDMA for various disasters, etc. which have been drawn under various initiatives to address risk and impacts of disasters, extremes and climate change.

3.14 National Disaster Management Authority (NDMA)

The Government of India established the NDMA in 2005, headed by the Prime Minister. Under the DM Act 2005, the NDMA, as the apex body for disaster management, shall have the responsibility for laying down the policies and guidelines for disaster management for ensuring timely and effective response to the disaster. NDMA has the power to authorize the Departments or authorities concerned, to make emergency procurement of provisions or materials for rescue and relief in a threatening disaster situation or disaster. The general superintendence, direction, and control of the National Disaster Response Force (NDRF) are vested in and are exercised by the NDMA. The National Institute of Disaster Management (NIDM) works within the framework of broad policies and guidelines laid down by the NDMA. The NDMA has the mandate to deal with all types of disasters – natural or human-induced. However, other emergencies such as terrorism (counter-insurgency), law and order situations, hijacking, air accidents, CBRN weapon systems, which require the close involvement of the security forces and/or intelligence agencies, and other incidents such as mine disasters, port and harbour emergencies, forest fires, oil field fires and oil spills are handled by the National Crisis Management Committee (NCMC). Nevertheless, NDMA may formulate the guidelines with advice/ inputs drawn from experts of DAE and facilitate training and preparedness activities in respect of response to RN emergencies with technical advice obtained from experts from DAE.

3.15 Farmers' Information Needs

Agricultural extension, or agricultural advisory services, comprises the entire set of organizations that support people engaged in agricultural production and facilitate their efforts to solve problems; link to markets and other players in the agricultural value chain; and obtain information, skills, and technologies to improve their livelihoods (Birner et al. 2009). Farmers require a diverse range of information to support their farm enterprises. Information is needed not only on best practices and technologies for crop production, which the traditional public-sector extension system provided during the Green Revolution, but also information about postharvest aspects including processing, marketing, storage, and handling. Farmers require information related to the following (Van den Ban 1998):

- The most appropriate technological options
- Management of technologies, including optimal use of inputs
- Changing farm system options (mixed farming and diversification, animal husbandry, fisheries)

- Sourcing reputable input suppliers
- Collective action with other farmers
- Consumer and market demand for products
- Quality specifications for produce
- Time to buy inputs and sell produce
- Off-farm income-generation options
- Implications of changing policies (input subsidies, trade liberalization)
- Access to credit and loans
- Sustainable natural resource management and coping with climate change

CHAPTER-4



RESEARCH METHODOLOGY

Appropriate methodology is needed to conduct particular research in any direction. The methodology incorporates different ideas for conducting the research in a smooth way and helps in understanding the techniques and methods utilized to design to study to collect the information to analyse the data and to interpret the data for relocation of truth and formulation of theories. The present study is delineated for the assessment of the agricultural extension needs of farmers for disaster resilience with the help of a structured research methodology adopted for the purpose of operationalizing and developing a conceptual framework. The research methodology for the present study includes:

4.1 Locale of research

4.2 Research design

4.3 Sampling design

4.4 Pilot study

4.5 Hypothesis

4.6 Conceptualisation, operationalisation and measurement of variables

4.7 Method of data collection

4.8 Statistical and other tools used for the analysis of data

4.1 Locale of research

The present study entitled "Assessment of Agricultural Extension Needs of Farmers for Disaster Resilience in Dhemaji district of Assam" was carried out in the Dhemaji district of Assam. The Dhemaji district has been selected for the following reasons:

- The selected study area is more vulnerable to natural hazards such as floods, drought, storms, landslides, river erosion, earthquakes etc.
- The people in the area are mostly dependent on agriculture and allied activities for their livelihood and hazards are much more impactful on the farming community.
- The researcher's close familiarity with the area, people and extension system.
- The farming community in the study is more responsive and practices various farm disaster risk reduction strategies depending on their crops and situations.
- Assam (60 % area of district) is identified as most climate vulnerable state as per study on Climate Change Vulnerability Assessment in the States of Indian Himalayan Region jointly conducted by IIT Guwahati, IIT Mandi and IISc Bangalore,2018
- Dhemaji district is one among the eight most flood prone districts of the country as reported by Council of Energy, Environment and Water, NewDelhi,2020

- Dhemaji and Nagaon districts of Assam are recognized as the most climate crisis-vulnerable districts in the country

4.2 Research design

The ex-post facto type of research design and participatory research design were followed to complete the entire study.

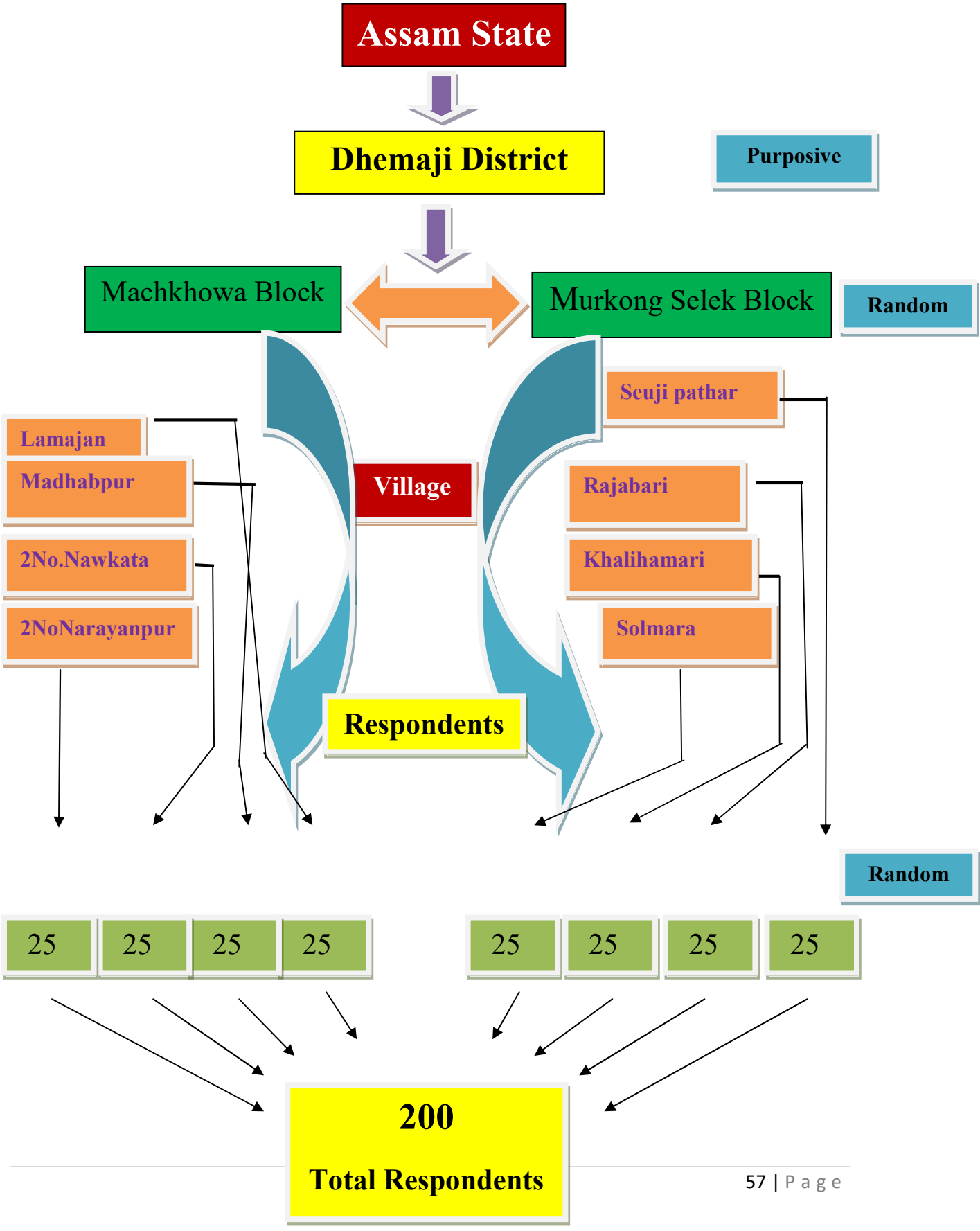
An ex post facto research design, also known as a retrospective or causal-comparative design, is a type of non-experimental research design used in social sciences. In this design, researchers investigate the causes or effects of a phenomenon after it has occurred. Ex post facto research is particularly useful when it is not possible or ethical to manipulate independent variables, making it challenging to establish causality. Instead, it focuses on exploring relationships between variables that naturally occur.

Participatory research design, often referred to as participatory action research (PAR), is a research approach that involves collaboration between researchers and the community or individuals being studied. It aims to empower participants by involving them in the research process, from problem identification to data collection, analysis, and the formulation of action plans or solutions. This approach is particularly common in social sciences and community-based research. Participatory research designs can vary in structure and methods, but they all emphasize active involvement, cooperation, and shared decision-making among researchers and participants.

4.3 Sampling design

A multistage, purposive-cum-random sampling technique was followed for selecting respondents for the study. The Dhemaji district of Assam was selected purposively for the present study. There are five Community Development Blocks in the Dhemaji district. Murkong Selek and Machkhowa Community Development Blocks were selected randomly out of five Blocks. A total of eight villages namely Lamajan Mising, Madhabpur, No.2 Narayanpur and No.2 Nawkata under Murkong Selek Tribal Community Development Block and Rajabari, Seujia Pathar, Khalihamari, Na-Pamua and Solmara under Machkhowa Development Block were selected randomly to carry out this study. An exhaustive list of farmers from each village was prepared with the help of the local people, local administrator (panchayat officials), block-level extension functionaries and Kishi Vigyan Kendra (KVK), Dhemaji. So, from the exhaustive list, twenty-five (25) farmers from each village were selected randomly for the present study to constitute a total of two hundred (200) numbers of farmer respondents.

Figure 4.1: Sampling Design of the Study



4.4 Pilot Study

A pilot study was conducted in the selected research areas before conducting the actual research activity. In the course of this survey, informal discussion was carried out with some non-respondent farmers, local leaders and agricultural functionaries of the locality. An outline of background information on diversified agricultural extension needs, disaster patterns experienced and their opinion and decision-making process were obtained for the construction of reformative working tools

4.5 Hypothesis

A defined hypothesis is a "tentative generalization, the validity of which remains to be tested". In the primary stages of research work, the hypothesis may be any imaginative idea, which becomes a base for the investigator to work and take action on the findings. Keeping in view the specific objectives of the present study, the following hypotheses are framed for the present study and described in the form of null hypothesis.

Ho1: There are no differences in the attributes among farmers in the study area

Ho2: There are no relationships between the attributes of farmers and resilience score

Ho3: There are no priorities for agricultural extension needs

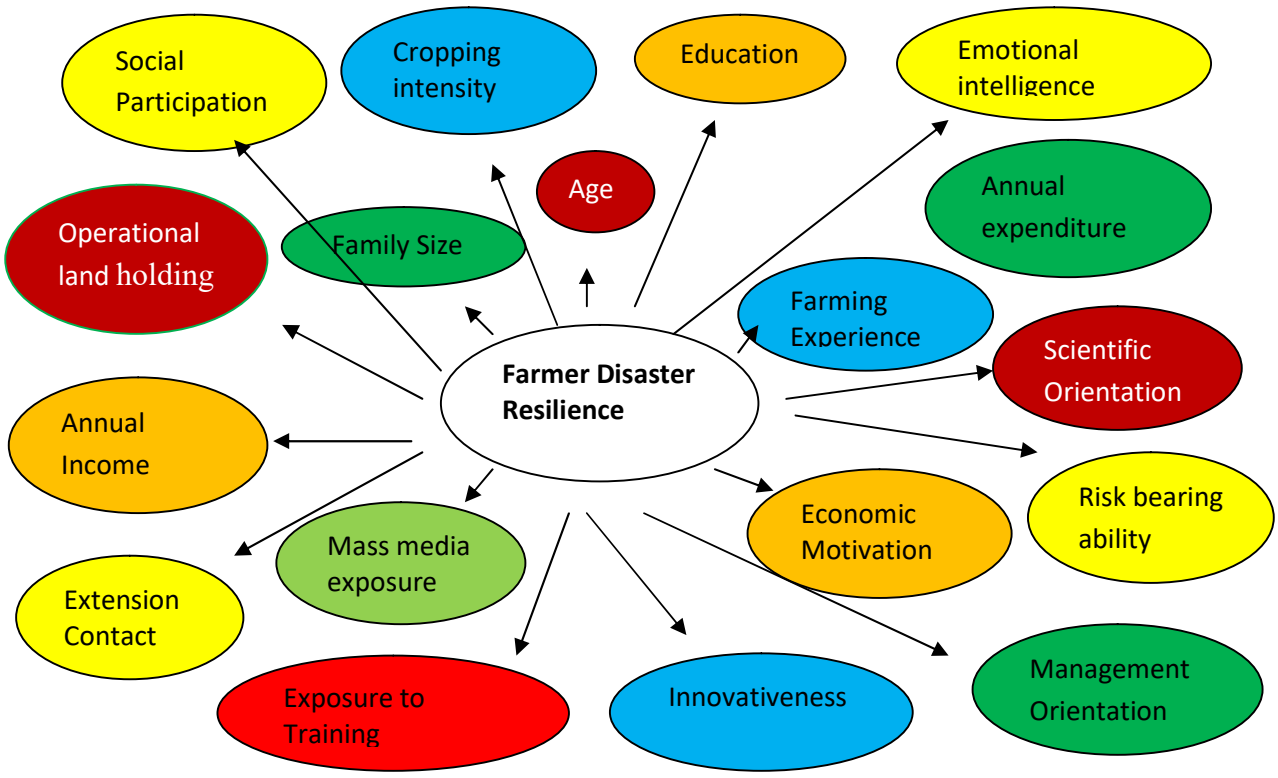


Fig 4.2: Hypothesis for the study

4.6 Conceptualization, operationalisation and measurement of variables

Measurement in general terms is expressed as the act of measuring something or an object or an event etc. To measure such an intended object, a constant scale is a prerequisite. A variable can be defined as a "thing that is observed and that is of such a nature that every single observation can be classified into one and only one of several mutually exclusive classes". After taking into consideration, the review of literature and discussion with the experts, the following eighteen independent and five dependent variables have been selected for the present study. The list of variables is grouped into the following categories and the scales used to measure these variables are listed in Table 4.1.

4.6.1 Independent variable

An Independent variable is defined as the variable that is changed or controlled in a scientific experiment. It represents the cause and reason for an outcome.

A. Socio-personal variables

1. Age

Age was operationalized as the chronological age of the respondent. It refers to the chronological age of a respondent at the time of the interview rounded off to the nearest year. The number of completed years was taken as the respondents' score on the variable. The respondents were categorized into three i.e. young-aged, middle-aged and old-aged aged based on the mean and standard deviation. The categorization was done by following the thumb rule of Mean±SD.

Sl. No.	Category	Score Range(n=200)
1.	Young Aged	<32 years
2.	Middle Aged	32 - 61 years
3.	Old Aged	>61 years

2. Family Education Status:

It refers to the education status of all the members of the family in the eligible age group for formal education i.e. excluding the children below six years of age. This variable is measured with the help of a procedure followed by Bhairamkar (2010). The total score is obtained by adding the respective standard completed by each member and the Family Education Status score is obtained by dividing the total score by the eligible number of family members. Family Education Status is calculated with the help of following formula;

$$\text{Family Education Status} = \frac{E1 + E2 + \text{----------} E_N}{N}$$

3. Farming Experience

It refers to the number of years the farmer respondent is engaged in cultivation at the time of the interview. In the present study, the number of years attained by the respondent is rounded to the nearest whole number noted during interviewing the respondent. Then the total respondents were categorized into three i.e. low, medium and high experience based on the mean and standard deviation. The categorization was done by following the thumb rule of Mean±SD.

Sl. No.	Category	Score Range(n=200)
1.	Low	<10 years
2.	Medium	10 - 39 years
3.	High	>39

4. Family Size

The family size is a representation of the total number of individuals present in a particular family. It is operationalized as the total number of family members living together in a house during the time of the interview. The score is assigned as per the total number of members of the family one each. The total respondents were categorized into three i.e. low, medium and high family size based on the mean and standard deviation. The categorization was done by following the thumb rule of Mean±SD.

Sl. No.	Category	Score Range(n=200)
1.	Small	<4 members
2.	Medium	4 - 7 members
3.	High	>7 members

B. Socio -economic variables

5. Size of operational land holding

Land holding is considered the economic position of a farmer in a rural community. It refers to the size of the land in terms of hectares (ha) operated by the respondent's family. The size of operational land holding includes the total of the owned cultivable land plus cultivable land leased in minus cultivable land leased out. It can be expressed as follows:

Size of operational land holding = (Cultivable land owned + Cultivable land leased in) – Cultivable land leased out. The total respondents were categorized into three i.e. low,

medium and high size of operational land holding based on the mean and standard deviation. The categorization was done by following the thumb rule of Mean±SD.

Sl. No.	Category	Score Range(n=200)
1.	Low	<1.24 ha
2.	Medium	1.2 - 3.2 ha
3.	High	>3.28 ha

6. Cropping Intensity:

Cropping Intensity will be calculated by the following formula

Cropping Intensity (CI) = (Gross cropped area/Net cropped area) X100.

It is expressed in percentage. The total respondents were categorized into three i.e. low, medium and high cropping Intensity based on the mean and standard deviation. The categorization was done by following the thumb rule of Mean±SD.

Sl. No.	Category	Score Range(n=200)
1.	Low	<100.10%
2.	Medium	100.10%- 136.00%
3.	High	>136.00%

7. Annual Income

The annual income of a family can be operationalized as the total earnings of every family member from primary and all secondary sources per year in rupees. The total respondents were categorized into three i.e. low, medium and high income categories based on the mean and standard deviation. The annual income of the respondents was measured with the help of a slightly modified scale developed by Venkatakrishnan (1991). The categorization was done by following the thumb rule of Mean±SD.

Sl. No.	Category	Score Range(n=200)
1.	Low	<Rs1,15000/
2.	Medium	Rs 1,15000/ - 2,87000/
3.	High	>Rs 2,87000

8. Annual expenditure

The annual expenditure of a family can be operationalized as the total spending of every family member on various activities per year in rupees. The total respondents have been

categorized into three i.e. low, medium and high annual expenditure categories based on the mean and standard deviation. The variable annual expenditure has been categorized into low, medium and high. The categorization was done by following the thumb rule of Mean ± SD

Sl. No.	Category	Score Range(n=200)
1.	Low	Rs 1,07000/
2.	Medium	Rs 1,07000/ - 2,47000/
3.	High	Rs 2,47000/

C. Extension-Communication variables

9. Social Participation

Social participation in any organization not only indicates a person's social orientation but also provides an opportunity for the individual to have wider contact and greater influence in the social system, which is very important for securing services from the resource centre or any other organization for socio-economic and cultural development. It is the degree of involvement in local organizations such as Village panchayat, Village Cooperative Society, Self Help Group, Labour organization, Farmers Club, Mahila Mandal either as a member scored as 1 or office bearer scored as 2 and their participation in organization activities. It was measured on a three-point continuum i.e. Always, Occasional and Never with scores of 2, 1 and 0 respectively. The modified scale of Trivedi (1963) was used for the measurement of social participation of respondents. The score obtained by an individual was summed up and then the mean and standard deviation were calculated. The total respondents were categorised into three i.e. low, medium and high Social Participation based on the mean and standard deviation. The categorization was done by following the thumb rule of Mean±SD.

10. Extension Contact

It refers to the frequency of contact between the respondent and the extension personnel like ADO, VLEW, KVK scientist, ATMA personnel, private extension personnel, NGO personnel, etc. within a specified period of time. The extension contact was measured in a three-point continuum viz. 'regularly' 'sometimes' and 'never'. The scores assigned were as follows.

Sl. No.	Category	Score
1.	Regularly	2
2.	Sometimes	1
3.	Never	0

The score obtained by an individual was summed up and then the mean and standard deviation were calculated. The total respondents were categorised into three i.e. low, medium and high extension contact based on the mean and standard deviation. The categorization was done by following the thumb rule of Mean±SD.

11. Mass media exposure

It refers to the frequency of reading or hearing newspapers, farm literature, listening to farm programmes, viewing farm T.V. programmes by the respondents. Frequencies of exposure to each of the mass media was measured in a three-point continuum viz. 'regularly' 'sometimes' and 'never'. The scores assigned were as follows.

Sl. No.	Category	Score
1.	Regularly	2
2.	Sometimes	1
3.	Never	0

The score obtained by an individual was summed up and then the mean and standard deviation were calculated. The total respondents were categorised into three i.e. low, medium and high mass media exposure based on the mean and standard deviation. The categorization was done by following the thumb rule of Mean±SD.

12. Training Exposure

It refers to the duration and number of training attended by the respondent on agriculture and allied subjects. On the basis of the duration of the training attended the scores were assigned as under,

Sl. No.	Category	Score
1.	No training	0
2.	One day training	1
3.	Two-day training	2
4.	Two-day training and above	3

The training exposure score worked out by multiplying the score on the duration of training by the number of training attended by the respondent. The total score indicated the training exposure of the respondent. The score obtained by an individual was summed up and then the mean and standard deviation were calculated. The total respondents were categorised into three i.e. low, medium and high training Exposure based on the mean and standard deviation. The categorization was done by following the thumb rule of Mean±SD.

D. Socio-psychological variables

13. Innovativeness

Rogers and Shoemaker (1971) defined innovativeness as the degree to which an individual is selectively earlier in adopting new ideas than other members of a social system. It was operationalized as the socio-psychological orientation of an individual to get linked or closely associated with change, adopting innovative ideas and practices. The modified scale of Prasad (1983) was used to measure innovativeness. The scale consists of seven statements. The response was obtained on a three-point continuum namely 'Yes', 'Undecided' and 'No' with a scoring pattern of 2,1 and 0, respectively. The summated score indicated the innovativeness of the respondent. By definition, the maximum possible score was 14 and the minimum possible was 0.

Based on the mean ($\overline{X}$) and standard deviations (S.D.) of the obtained scores, the respondents were classified into three categories as shown below:

Sl. No.	Category	Score range
1.	Low **Innovativeness**	Below ($\overline{X}$ – 1SD)
2.	Medium **Innovativeness**	($\overline{X}$ – 1SD) to ($\overline{X}$ + 1SD)
3.	High **Innovativeness**	Above ($\overline{X}$ + 1SD)

14. Economic motivation

It refers to occupational success in terms of profit maximization and the relative value an individual places on economic ends. The degree of economic motivation of the respondents was measured with the help of a scale developed by Supe (1969). The scale consisted of six statements of which the first five statements were positive and the last one was negative. The responses were recorded on a five-point continuum ranging from strongly agree, agree, undecided, disagree and strongly disagree with scores of 7,5,4,3 and 1 respectively and reverse score values were assigned in case of a negative statement. For this variable, the score ranged from 6 to 42. The scoring procedure for positive statements was as follows:

Sl. No.	Response Category	Score
1.	Strongly Agree	7
2.	Agree	5
3.	Undecided	4
4.	Disagree	3
5.	Strongly Disagree	1

The total score obtained on the scale was taken as the respondent's score on the variable. Based on the mean ($\bar{X}$) and standard deviations (S.D.) of the obtained scores, respondents were classified into three categories as shown below:

Sl. No.	Category	Score range
1.	Low Economic motivation	Below ($\bar{X}$ – 1SD)
2.	Medium Economic motivation	($\bar{X}$ – 1SD) to ($\bar{X}$ + 1SD)
3.	High Economic motivation	Above ($\bar{X}$ + 1SD)

15. Scientific Orientation

It was defined as the degree to which a farmer is oriented towards scientific techniques and thinking in his/her outlook (Supe, 1969). It was measured by using the scientific orientation scale developed by Supe (1969). The scale consisted of six statements out of which one statement was negative, while the rest were positive. The responses of the respondents were obtained against each statement in terms of their agreement or disagreement. The scoring procedure for positive statements was as follows:

Sl. No.	Response Category	Score
1.	Strongly Agree	7
2.	Agree	5
3.	Undecided	4
4.	Disagree	3
5.	Strongly Disagree	1

The reverse of the above scoring procedure was followed in the computation of the negative statement. Each individual respondent was located on the scale by his/her score. The total scores on the scale theoretically ranged from 6 to 42. Based on the mean ($\bar{X}$) and standard deviations (S.D.) of the obtained scores, the respondents were classified into three categories as shown below:

Sl. No.	Category	Score range
1.	Low Scientific Orientation	Below ($\bar{X}$ – 1SD)
2.	Medium Scientific Orientation	($\bar{X}$ – 1SD) to ($\bar{X}$ + 1SD)
3.	High Scientific Orientation	Above ($\bar{X}$ + 1SD)

16. Management Orientation

Management orientation has been defined as the degree to which a farmer is oriented towards scientific farm management comprising planning, production and marketing functions of his farm. It was measured by using the Management Orientation Scale developed by Samanta (1977). The scale had three components *viz*, planning orientation, production orientation and marketing orientation with 6 statements under each component. The statements with serial numbers (i), (iii), (vi) related to planning, (i), (iii), (iv), and (v) related to production and (ii), (iii) and (vi) related to marketing indicated positive orientation, while the remaining statement indicated negative orientation. The positive statements were given scores of strongly agree-4, agree-3, disagree-2, and strongly disagree 1. Scoring was reversed for the negative statements.

The theoretical range of scores on the scale was from 18 to 72. The management orientation score of an individual respondent was the sum of scores for all the statements in the scale. The scoring procedure for positive statements was as follows:

Sl. No.	Response Category	Score
1.	Strongly Agree	4
2.	Agree	3
3.	Disagree	2
4.	Strongly Disagree	1

Based on the mean ($\bar{X}$) and standard deviations (S.D.) of the obtained scores, respondents were classified into three categories as shown below:

Sl. No.	Category	Score range
1.	Low Management orientation	Below ($\bar{X}$ – 1SD)
2.	Medium Management orientation	($\bar{X}$ – 1SD) to ($\bar{X}$ + 1SD)
3.	High Management orientation	Above ($\bar{X}$ + 1SD)

17. Risk bearing ability

It is the degree to which a farmer is oriented toward risk and uncertainty in farming and has courage to face problems in farming. A five-point rating scale developed by Supe (1969) with five response categories *i.e.* strongly agree, agree, undecided, disagree and strongly disagree was used for measuring this variable. The scale consisted of four positive and two negative statements. The scoring procedure for statements was as follows:

Sl. No.	Response Category	Score
1.	Strongly Agree	7
2.	Agree	5
3.	Undecided	4
4.	Disagree	3
5.	Strongly Disagree	1

The scoring procedure was reversed for the negative statements. Total score on this scale ranged from 6 to 42. Based on the mean ($\bar{X}$) and standard deviations (S.D.) of the obtained scores, respondents were classified into three categories as shown below:

Sl. No.	Category	Score range
1.	Low Risk bearing ability	Below ($\bar{X}$ – 1SD)
2.	Medium Risk bearing ability	($\bar{X}$ – 1SD) to ($\bar{X}$ + 1SD)
3.	High Risk bearing ability	Above ($\bar{X}$ + 1SD)

18. Emotional intelligence

Emotional intelligence refers to the ability to perceive, control and evaluate emotions. The modified scale of Mehta and Singh (2013) was used to measure the emotional intelligence. The scale consists of six dimensions with numbers of statements. The response was obtained on a five point continuum namely strongly agree, agree, undecided, disagree and strongly disagree with a scoring pattern of 5,4,3,2 and 1, respectively. Total score on this scale ranged from 32 to 224.The summated score indicated the emotional intelligence of the respondent. Based on the mean ($\bar{X}$) and standard deviations (S.D.) of the obtained scores, respondents were classified into three categories as shown below:

Sl. No.	Category	Score range
1.	Low Emotional intelligence	Below ($\bar{X}$ – 1SD)
2.	Medium Emotional intelligence	($\bar{X}$ – 1SD) to ($\bar{X}$ + 1SD)
3.	High Emotional intelligence	Above ($\bar{X}$ + 1SD)

4.6.2 Dependent Variable

A. Farmer Resilience Index

4.6.2.1 Development of Index to assess the Farmers' disaster resilience through Farmer Resilience Index

Farmer disaster resilience is operationally defined as the ability of farmers within a village to absorb, manage, and bounce back from a disaster. The resilience of farmers at a village level is all about equipping them to absorb and recover from shocks and stresses to their agricultural production and livelihoods. Farmer Resilience Index is developed in the study to get comprehensive picture of Farmer disaster resilience framework. Farmer Resilience Index is conceptualized and operationalized through four dimensions namely economic resilience index, social resilience index, technical resilience index, and physical resilience index with each dimension having individual variables to determine the resilience of the farmers. In order to cope with the ill effects of disasters farmers develop resilience capacity with new technologies and practices to overcome the risks and uncertainties in the farming due to various types of natural disasters. It is important to measure the disaster resilient level of farmers and helps in taking up the decisions in the policy making for sustainable agricultural development.

4.6.2.1.1 Collection and Editing of Items

A list of possible statements/items covering economic, social, technical and physical aspects which were relevant to measure the farmers' disaster resilience with reference to North Bank Agro-Climatic Zone of Assam was identified. An exhaustive list of 105 statements/items was drafted through review of literature, experts' opinion and informal discussion with the subject experts and farmers. The items were edited and written in such a way that each item highlighted a single idea having no ambiguity and with a logical sequence.

The statements were further edited as per the 14 criteria suggested by Edwards (1969), and Thurstone and Chave (1929). Out of 107 statements 17 statements were eliminated and the remaining 90 statements were included for the study**.** The all draft 90 statements were mailed to 40 experts using Google Form in the agricultural extension and other related fields working in SAUs, KVKs, ICAR institutions, State Department of Agriculture. The judges were requested to critically assess the each statement for its relevance. The judges were asked to give their answer on a 3-point continuum, namely, the most relevant, relevant and the least

relevant and later the score of 3, 2 and 1, respectively were assigned to consolidate the response.

The judges were also requested to make necessary modifications and additions or deletion of statements, if they desire so. A total of 32 experts returned the questionnaires duly completed were considered for further processing. From the data gathered, Relevancy Percentage (RP), Mean Relevancy Weightage (MRW), and Mean Relevancy Score (MRS) were calculated for each of the 90 statements individually using the following formulae:

Relevancy Percentage (RP) = (FS / Number of respondent) × 100

Mean Relevancy Weightage (MRW) = (MRR x 3 + RR x 2 + LR x1)/MPS

Mean Relevancy Score (MRS) = (MRR x 3 + RR x 2 + LR x1)/No. of judges

Where,

FS= Frequency score of most relevant and relevant

MRR= Most Relevant Response, RR= Relevant Response

LRR = Least Relevant Response

MPS= Maximum Possible Scores (No. of judges responded ×3)

Using these criteria, the statements were selected for their relevance. Statements with a relevance percentage> 70, an mean relevance weightage > 0.70 and an mean relevance score> 2 were selected for the final selection of statements. Through this process, 78 statements were selected and amended and rewritten based on expert feedback.

4.6.2.1.2 Item analysis

Item analysis is an important step according to Likert's technique of constructing a valid and reliable scale. To delineate the statements, based on the extent to which they can differentiate the farmers' disaster resilience as low, item analysis was carried out on the statements selected in the first stage. For item analysis, statements were arranged in ascending order based on relevancy score. The't' value of the statements were calculated by using following formula

$$t = \frac{X_H - X_L}{\sqrt{S^2_H / n_H + S^2_L / n_L}}$$

X_H = the mean score on a given statement for the high H group

X_L= the mean score on the same statement for the low group

S^2_H = the variance of the distribution of responses of high H group to the statement

S^2_L = the variance of the distribution of responses of low L group to the statement

n_H = number of subjects in the high group;

n_L = number of subjects in the low group

After calculating the "t" value for all items, 72 statements with the highest "t" value equal to or greater than 1.75 were selected.

4.6.2.1.3 Reliability and validity of the Index

The study was conducted in the Biswanath district of Assam where 30 farmers were selected from, the non-sample area of Biswanath block. Split half method developed by Brown Prophecy was employed to measure the reliability of the scale. The calculated value of the correlation coefficient was 0.8417 and this was further calculated by using the Spearman-Brown formula (Guilford and Fruchter 1978) and obtaining the reliability coefficient of the whole test. The value of the scale was 0.9174 which was highly significant at one percent level indicating the high reliability of the scale. As the content of the tool thoroughly covered the universe of farmers' disaster resilience through literature review and experts' opinions, it was assumed that the present tool satisfies the content validity. Hence, the scale is said to be valid. Thus, the developed index/scale to measure the farmers' disaster resilience was feasible and appropriate.

4.6.1.2.4 Computation of Farmer Resilience Index

The final Farmer Resilience Index consists of 72 items under four dimensions namely economic resilience, social resilience, technical resilience, and physical resilience for determining the disaster resilience of farmers. Each item is scored a value between 1 and 5 with 1 being the lowest score and 5 being the highest score. The principal component analysis (PCA) is done for the variables under each dimension separately for fixing the weights. The weightage of the respondent score is fixed based on component loadings less than 0.50 of the first principal component. Following fixing weights for each variable, the weightage assigned is multiplied with the respondent score to calculate the Resilience Index. Dimension-wise Resilience Index is calculated with the following equation.

$$\text{Dimension-wise Resilience Index}_i = \frac{\sum_{j=1}^{n} (\text{weightage} * \text{variable score})_j}{n}$$

where i is the dimension (four dimensions) and j is the number of variables under the corresponding dimension

The Dimension-wise Resilience Index includes the Economic Resilience Index, Social Resilience Index, Technical Resilience Index and Physical Resilience Index. The composite or overall Farmer Resilience Index (FRI) is calculated as the mean of Economic Resilience Index (ERI), Social Resilience Index (SRI), Technical Resilience Index (TRI) and Physical Resilience Index (PRI)

$$\textbf{FRI=} (ERI+ SRI+ TRI+ PRI)/4$$

B. Agricultural Extension needs for disaster resilience

The present study is concentrated to understand the Agricultural Extension needs of the farmer respondents during the whole agricultural year from the beginning of sowing to even after harvesting for disaster resilience. An Exhaustive list of agricultural extension needs is prepared with the discussion of experts and available literature related to farmers disaster resilience. It is operationalized as various agricultural extension needs of the farmer respondents on the thematic areas of agricultural input materials, agricultural finance, agricultural production, post harvest management, agricultural marketing, livelihood diversification, under three dimensions of Agricultural Extension needs namely up to date information ,Training and Demonstration and Mitigation strategy . The Garrette Ranking Technique is used to rank the preference on different thematic areas of agricultural extension needs under three dimensions of Agricultural Extension needs of the farmer for mitigating the farm disasters as perceived by them.

Founded on the Garrette's Ranking Technique, the rank preferred on agricultural extension need by respondent based on their farming experience are converted into score value and rank with the help of following formula

$$\text{Percent position} = \frac{\mathbf{100(Rij-0.5)}}{\mathbf{Nj}}$$

Where,

Rij = Rank given for the i^{th} variable by j^{th} respondents

Nj = Number of variable ranked by j^{th} respondents

With the help of Garrette' Table, the percent position estimated is converted into scores by referring to the table given by Garret and Woodworth(1969).Then for each extension need, the scores of each individual respondent are added and then total value of scores and mean values of score is calculated. The extension need having highest value is considered to be most important need.

C. Challenges associated with Agricultural Extension needs and disaster resilience

The present study is also aimed to understand the constraints associated with Agricultural Extension needs and disaster resilience of the farmer respondents during the whole agricultural year from the beginning of sowing to even after harvesting. An exhaustive list of challenges associated with agricultural extension needs and disaster resilience is prepared with the help of experts and available related literature. It is operationalized as various constraints associated with Agricultural Extension needs and disaster resilience of the farmer respondents on the thematic areas of Socio economic constraints; Technical constraints; Physical and Infrastructural constraints, and Organizational/Institutional constraints. The Garrette Ranking Technique is used to rank the constraints on different thematic areas namely Socio economic; Technical; Physical and Infrastructural, and Organizational/Institutional for framing appropriate policies and strategies to mitigate the farm disasters as perceived by farmer respondents.

Founded on the Garrette's Ranking Technique, the rank constraints on different thematic areas by respondent based on their farming experience are converted into score value and rank with the help of following formula

$$\text{Percent position} = \frac{100(Rij-0.5)}{Nj}$$

Where,

Rij = Rank given for the i^{th} variable by j^{th} respondents

Nj = Number of variable ranked by j^{th} respondents

With the help of Garrette' Table, the percent position estimated is converted into scores by referring to the table given by Garret and Woodworth(1969).Then for each constrain, the scores of each individual respondent are added and then total value of scores and mean values of score is calculated. The constrain having highest value is considered to be most significant constraint.

Table 4.1: Variables selected for the present study and their empirical measurement

Sl. No.	Variable	Measurement
Independent Variable		
Socio-personal variable		
1.	Age(X_{01})	Structured Schedule
2.	Family education(X_{02})	The modified scale of Bhairamkar(2009)
3.	Farming experience(X_{03})	Structured Schedule
4.	Family size(X_{04})	The modified scale of Venkataramaiah(1983)
Socio-economic variable		
5.	Operational land holding(X_{05})	Structured Schedule
6.	Cropping intensity(X_{06})	Structured Schedule
7.	Annual income(X_{07})	The modified scale of Venkatakrishnan (1991)
8.	Annual expenditure(X_{08})	Structured Schedule
Extension-communication variable		
9.	Social participation(X_{09})	The modified scale of Trivedi(1963)
10.	Extension contact(X_{10})	Structured Schedule
11.	Mass media exposure(X_{11})	Structured Schedule
12.	Training exposure(X_{12})	Structured Schedule
Socio-psychological variable		
13.	Innovativeness(X_{13})	The modified scale of Prasad(2007)
14.	Economic motivation(X_{14})	A scale developed by Supe (1969)
15.	Scientific orientation(X_{15})	A scale developed by Supe (1969)
16.	Management orientation(X_{16})	A scale developed by Samanta (1977)
17.	Risk bearing ability(X_{17})	A scale developed by Supe (1969)
18.	Emotional intelligence(X_{18})	The modified scale of Mehta and Singh(2013)
Dependent Variable		
1.	Economic Resilience Index(Y_1)	Structured Schedule developed for study
2.	Social Resilience Index(Y_2)	Structured Schedule developed for study
3.	Technical Resilience Index(Y_3)	Structured Schedule developed for study
4.	Physical Resilience Index(Y_4)	Structured Schedule developed for study
5.	Farmer Resilience Index(Y)	Structured Schedule developed for study
Others		
1.	Agricultural extension needs	Garrette Ranking Technique
2.	Agricultural extension challenges	Garrette Ranking Technique

4.7. Method of Data Collection

4.7.1 Construction of Schedule after Pre-testing

The draft schedule for collection of data, incorporating the tools and techniques of different variables was presented to take the expert advice. The quantification was done for each and every variable after operationalizing them. Before final data collection, entire schedule was pre-tested for elimination, addition and alteration with non-sample respondents of the study

area. In pre-testing, care was taken not to include respondents who were selected as sample for final interview. On the basis of experiences in pre-testing, appropriate changes in the construction of item and their sequence were made. The schedule was then finalized and multiplicated. The final form of the schedule is given in the appendix

4.7.2 Field Data Collection

The data were collected from 200 farmer respondents from September 2022 to April, 2023 with the help of the schedule constructed for the study through the personal interview method. In each selected village, before starting the interview, a few days were devoted to establishing rapport with the respondents. The schedule was administered to the respondents in the local language and the responses were recorded in English on the schedule. The interview was carried out by the researcher himself.

The participatory data collection method was used to collect the information from different stakeholders through the Focus Group Discussion (FGD) method to prepare a participatory model with the help of Fuzzy Cognitive Mapping (FCM). The data were collected with the help of a Semi-structured interview schedule and followed steps like defining the objective and scope, selection of stakeholders, generation of knowledge, aggregation of qualitative concepts, weighting connections and aggregating quantification.

4.8 Statistical and other tools used for the analysis of data

Origin Pro version 2021 and Statistical Package for Social Sciences (IBM-SPSS) version 17 software were used for analysis of the conventional data and the software Mental Modeller was used to analyse the data collected through participatory mode to construct a paradigm with the help of Fuzzy Cognitive Mapping. Descriptive statistics such as mean, percentage, range, standard deviation and coefficient of variations were employed to summarize the data. Finally, Pearson correlation analysis, coefficient of correlation analysis, multiple correlation regression analysis artificial neural network, and principal component analysis were used to identify determining factors on the farmers' disaster resilience. Based on the statistical analysis performed as mentioned earlier, relationships amongst the respondents in terms of responses towards the main influencing traits, which are of utmost importance, have been depicted in the descriptions of results in the Result and Discussion chapter.

4.8.1 Mean

The mean is the arithmetic average and is the result obtained when the sum of the value of individual in the data is divided by the number of individuals in the data. Mean is simplest and relatively stable measure of central tendency. The mean reflects and is affected by every score in the distribution. We can work it out as follows,

$$\bar{x}=\Sigma X/N$$

Where,

$\bar{x}$ = mean of the scores

Σx = sum of individual scores

N = number of observations

4.8.2. Standard Deviation

Standard deviation (SD) is the most widely used measure of dispersion of a series and is commonly denoted by the symbol σ (pronounced as sigma) Standard deviation is the square root of the arithmetic mean of the square of the deviations, the deviations being measured from the arithmetic mean of distribution. It is less affected by sampling errors and is more stable measure of dispersion. SD is worked out as follows,

$$\sigma = \sqrt{\Sigma f \cdot d2/N}$$

Where,

f = frequency of the class

d= deviation of the mid-value of the class from the population mean

N= total number of observations

4.8.3. Range

The range of a distribution is the difference between the smallest and largest of observations and gives us some idea of the amount of variability present (Panse and Sukhatme, 1967). The range is the most general measure of spread or scatters and may be computed to make a rough comparison of two or more groups for variability.

4.8.4. Coefficient of Variation

A measure of variation which is independent of the unit of measurement is provided by Coefficient of variation. Being unit free, this is useful for computation of variability between different populations. The Coefficient of variation is standard deviation expressed as percentage of the mean and is measured by the formula.

$$CV= SD/Mean \times 100$$

4.8.5. Coefficient of Correlation

When an increase or decrease in one variable is accompanied by an increase or decrease in other variable, the two are said to be correlated and the phenomenon is known as correlation. Correlation coefficient (r) is a measure of the relationship between two variables, which are at the interval or ratio level or measurement and are linearly related. A Karl Pearson's coefficient of correlation also known as product moment 'r' is computed by the formula:

$$r_{xy} = \boldsymbol{N\Sigma XY} - (\Sigma \boldsymbol{X})(\Sigma \boldsymbol{Y}) / \sqrt{[\boldsymbol{N\Sigma X2} - (\Sigma \boldsymbol{X})\boldsymbol{2}]\ [\boldsymbol{N\Sigma Y2} - (\Sigma \boldsymbol{Y})\boldsymbol{2}]}$$

When,

X and Y = original scores in variables X and Y

N = number of paired scores

ΣXY = each X multiplied by its corresponding Y, then summed

ΣX = sum of X scores

$\Sigma X2$ = each X squared, then summed

$(\Sigma X)2$ = sum of X scores, squared

ΣY = sum of Y scores

$\Sigma Y2$ = each Y squared, then summed

$(\Sigma Y)2$ = sum of Y scores, squared

Correlation coefficient ranges between -1 to +1. It delineates that -1 is perfect negative correlation, +1 is perfect positive correlation. If the numbers of errors increase with increase in typing speed, it indicates positive correlation and if the numbers of correct words decrease with increase in typing speed, it is indicative of negative correlation. A correlation coefficient to be acceptable should be statistically significant. Otherwise, we say that no significant relationship exists between the variables.

4.8.6. Multiple Regression Analysis

Regression is the determination of a statistical relationship between two or more variables. In simple regression, we have only two variables, one variable (defined as independent) is the cause of the behavior of another one (defined as dependent variable). Regression can only interpret what exists physically i.e., there must be a physical way in which independent variable X can affect dependent variable Y. The basic relationship between X and Y is given by

$$Y = a + bX$$

Where the symbol Y denotes the estimated value of Y for a given value of X. This equation is known as the regression equation of Y on X (also represents the regression line of Y on X when drawn on a graph), which is positive for direct and negative for inverse relationships.

Thus, the regression analysis is a statistical method to deal with the formulation of mathematical model depicting relationship amongst variables, which can be used for the purpose of prediction of the values of dependent variable, given the values of the independent variable.

When there are two or more than two independent variables, the analysis concerning relationship is known as multiple correlation and the equation describing such relationship as the multiple regression equation. We here explain multiple correlation and regression taking only two independent variables and one dependent variable (convenient computer programmes exist for dealing with a great number of variables). In this situation the results are interpreted as shown below:

Multiple regression equation assumes the form

$Y = a + b_1X_1 + b_2X_2$

Where X_1 and X_2 are two independent variables and Y being the dependent variable, and the constants a, b_1 and b_2 can be solved by solving the following three normal equations:

$\sum Yi = na + b_1\sum X_{1i} + b_2\sum X_{2i}$

$\sum X_{1i}Y_i = a\sum X_{1i} + b_1\sum X^2_{1i} + b_2\sum X_{1i}X_{2i}$

$\sum X_{2i}Y_i = a\sum X_{2i} + b_1\sum X_{1i}X_{2i} + b2\sum X^2_{2i}$

(It may be noted that the number of normal equations would depend upon the number of independent variables. If there are 2 independent variables, then 3 equations, if there are 3 independent variables then 4 equations and so on, are used). In multiple regression analysis, the regression coefficients (viz., b_1, b_2) become less reliable as the degree of correlation between the independent variables (viz., X_1, X_2) increases. If there is a high degree of correlation between independent variables, we have a problem of what is commonly described as the problem of multicollinearity. In such a situation we should use only one set of the independent variable to make our estimate. In fact, adding a second variable, say X_2, that is correlated with the first variable, say X_1, distorts the values of the regression coefficients. Nevertheless, the prediction for the dependent variable can be made even when multicollinearity is present, but in such a situation enough care should be taken in selecting the independent variables to estimate a dependent variable so as to ensure that multicollinearity is reduced to the minimum.

With more than one independent variable, we may make a difference between the collective effect of the two independent variables and the individual effect of each of them taken separately. The collective effect is given by the coefficient of multiple correlations. In multiple regressions we form a linear composite of explanatory variables in such a way that it has maximum correlation with a criterion variable. The main objective in using this technique is to predict the variability of the dependent variable based on its covariance with all the independent variables. One can predict the level of the dependent phenomenon through multiple regression analysis model, given the levels of independent variables.

4.8.7 Stepwise Multiple Regression

Stepwise regression is a variation of multiple regressions which provides a means of choosing independent variables that yield the best prediction possible with the fewest independent variables. It permits the user to solve a sequence of one or more multiple linear regression problems by stepwise application of the least square method. At each step in the analysis, a variable is added or removed which results in the greatest production in the error sum of squares.

4.8.8 Principal Component Analysis

There are several methods of factor analysis. The method of Principal Component Analysis which is widely used is discussed here.

The principal component analysis extracts m-eigenvectors (principal component axes) and corresponding m-Eigen values (the variance measured along the eigenvector) from m x m symmetrical matrix of correlation.

The Eigen vectors obtained from this principal component analysis are all orthogonal (i.e. inter-column correlations are near zero). The Eigen values account for all of the original data variances in decreasing order such that each has variance or Eigen value less than the previous ones. The total of the eigen values:

$$(\lambda_1+ \lambda_2+ \lambda_3+ \lambda_4+ \lambda_5+ \lambda+\cdots\cdots\cdots\cdots \lambda_m)$$

This is the same as the sum of the variances constituting the diagonal or trace of the correlation matrix before transformation. The principal components are then converted into factors by multiplying each element of the principal components or Eigen vectors (v) by the square – root of the corresponding Eigen values ($\lambda^{1/2}$. v). Factors, thus, besides the direction also represent the variances. Kaiser (1958) and others have recommended retaining all those eigen values, which have values more than one.

Next step is to remove the noise imposed by (m-p) unnecessary axes. To accomplish this, p-orthogonal reference axes or factors are routed about the origin to positions such that the variance of the loading from each variable onto each factor axis is either extreme (±1) or zero. This maximization of the range of the loadings was performed by using Kaiser's varimax criterion. Scanning through each factor column for large absolute values in the varimax matrix will reveal a few variables with significantly high loadings and many others with insignificantly loadings. The column showing communality is the total amount of variance of each variable retained in the factors, and is computed by summing the squares of the elements of the factors in each row of varimax matrix. Fairly high communality of each variable implies the appropriateness of the model adopted, for the study. The last step involved interpretation of the factors.

4.8.9. Artificial Neural Network (ANN)

Artificial neural networks (ANNs), usually simply called neural networks (NNs), are computing systems inspired by the biological neural networks that constitute animal brains. An artificial neural network (or simply neural network) consists of an input layer of neurons (or nodes, units), one or two (or even three) hidden layers of neurons, and a final layer of output neurons. Each connection is associated with a numeric number called weight. The output, hi, of neuron i in the hidden layer is,

$$hi = \sigma\ (\Sigma \boldsymbol{N_{j=1}}\ \boldsymbol{V}_{i\,j}\ X_j + T_i^{hid}) \text{ where,}$$

σ () = activation (or transfer) function,

N = number of input neurons,

$V_{i\,j}$ =weights,

X_j = inputs to the input neurons,

T_i^{hid} = threshold terms of the hidden neurons.

The purpose of the activation function is, besides introducing nonlinearity into the neural network, to bind the value of the neuron so that the neural network is not paralyzed by divergent neurons. It has been shown that a neural network constructed the way above can approximate any computable function to an arbitrary precision. Numbers given to the input neurons are independent variables and those returned from the output neurons are dependent variables to the function being approximated by the neural network. Inputs to and outputs from a neural network can be binary (such as yes or no) or even symbols (green, red ...) when data are appropriately encoded. This feature confers a wide range of applicability to neural networks.

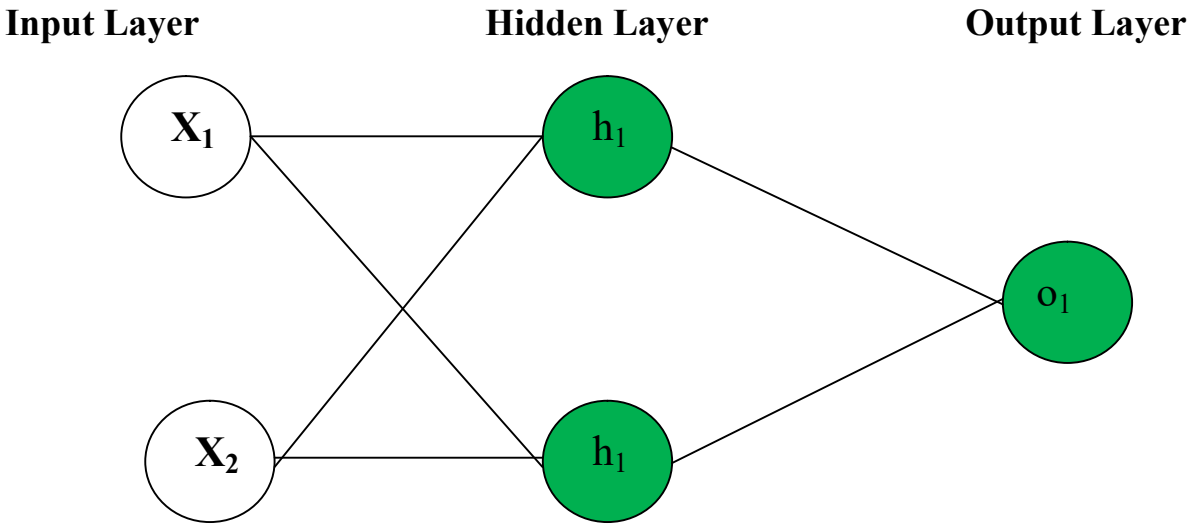


Diagram of neural analysis

4.8.10 One-way ANOVA (Analysis of Variance)

In statistics, **one-way analysis of variance** (or **one-way ANOVA**) is a technique to compare whether two samples' means are significantly different (using the F distribution). This analysis of variance technique requires a numeric response variable "Y" and a single explanatory variable "X", hence "one-way".

The ANOVA tests the null hypothesis, which states that samples in all groups are drawn from populations with the same mean values. To do this, two estimates are made of the population variance. These estimates rely on various assumptions (see below). The ANOVA produces an F-statistic, the ratio of the variance calculated among the means to the variance within the samples. If the group means are drawn from populations with the same mean values, the variance between the group means should be lower than the variance of the samples, following the central limit theorem. A higher ratio therefore implies that the samples were drawn from populations with different mean values.(Wikipedia)

Typically, however, the one-way ANOVA is used to test for differences among at least three groups, since the two-group case can be covered by a t-test (Gosset, 1908). When there are only two means to compare, the t-test and the F-test are equivalent; the relation between ANOVA and t is given by $F = t^2$. An extension of one-way ANOVA is two-way analysis of variance that examines the influence of two different categorical independent variables on one dependent variable.

4.8.11 Participatory Modelling tool Fuzzy Cognitive Mapping (FCM)

Fuzzy cognitive mapping (FCM) is a technique, which builds quasi-quantitative models from the knowledge of interconnected variables in a system. FCM is suitable for linking stakeholders' knowledge and scientific knowledge in modelling a complex social-ecological system and has been praised for the ease and speed of obtaining and combining different knowledge sources. An FCM represents the variables of a system as ‘concepts’ and assesses the strength between these concepts as causal ‘connections’ represented by arrows with positive (+) or negative (−) values between −1 and 1. The particular strength of FCM is in the fact that it can be used to analyze the quasi-dynamic behaviour of the system derived by multiplying the FCM's weight matrix by the state vector. FCMs are useful in modelling complex social-ecological systems as perceived/understood by the stakeholders living and working in the system. The nature of FCM makes it easy for stakeholders to participate in the diagramming of the map or in contributing knowledge for the map building either individually or as a group. FCMs are particularly flexible in allowing the inclusion of both quantifiable and difficult to quantify aspects of a complex system; as well as the different

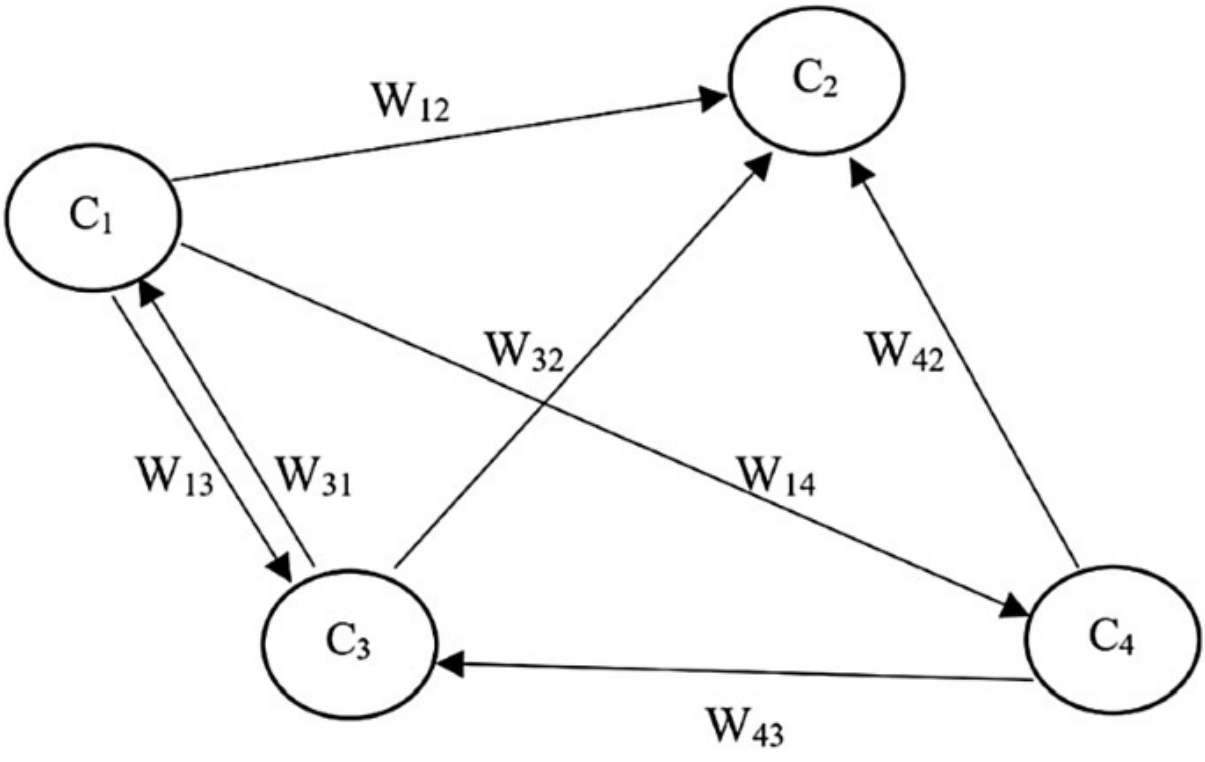
domains of the system. Crucial steps in the development methods of an FCM include data collection which in participatory model settings is knowledge elicitation from stakeholders; knowledge analysis and FCM aggregation.

FCMs are soft computing techniques that combine fuzzy logic and neural networks. They were first introduced by Kosko as fuzzy-graph structures for representing causal reasoning. They provide a more flexible and natural ability for knowledge representation and reasoning, which are essential to intelligent systems. A set of nodes (concepts), representing the key elements of the given system, and directed arcs (links), defining the causal relationships between the nodes, form an FCM. Each concept is indicated by Ci, i = 1, ... , N (where N is the number of concepts in the problem domain) and is also specified by an activation value Ai in [0, 1]. The links are labelled with fuzzy weights in the interval of [0, 1] or [−1, +1], which show the strength of the impact between the concepts. Weights of links are associated with a weight value matrix E N x N, where each element of the matrix Wij takes values in [−1, +1]. There are three types of weights:

• Wij = 0 indicates no causality between concepts;

• Wij >0 indicates a causal increase (i.e.,Cj increases as Ci increases, and Cj decreases as Ci decreases);

• Wij<0 indicates a causal decrease (i.e.,Cj decreases as Ci increases, and Cj increases as Ci decreases)



CHAPTER-5



RESEARCH SETTING

This chapter is intended to present a bird's eye view of the area, where the present study has been carried out. It has been carried out in the district of Dhemaji under the North Bank Plains Agro-climatic Zone of Assam. The setting of this study sought to describe in terms of social, economic and agricultural aspects of areas viz., State, District, Block and at the village level. The information interpreted in this chapter is mainly based on secondary data available on different websites and Govt. offices. The primary sources of information are census reports, www.dhemaji.nic.in ,www.villageinfo.in.

5.1 Macro-Research Setting

5.1.1 Geo-Natural Positioning of North East India

The North Eastern Region (NER) of India comprises the states of Assam, Manipur, Nagaland, Arunachal Pradesh, Mizoram, Sikkim and Tripura. The region stretches between 21°50' and 29°34' N latitude and 85°34' and 97°50' E longitude. The region has a population of 39 m and a geographical area of 26.2 million hectares, which is 3.85% and 8% of the population and area of the country, respectively. Out of the total geographical area, 28.3% has an elevation of more than 1200 m, 17.9% between 600 and 1200 m and about 10.8% between 300 m and 600 m above mean sea level. The region has about 72% area under hilly ecosystems. The region has inaccessible terrain, fragility, marginality, excessive sloping land with rolling topography, rich biodiversity, unique ethnicity and socio-ecological setup. The NER receives high rainfall and is therefore clothed with diverse and dense vegetation. The North Eastern states are believed to be highly vulnerable to the impacts of natural disasters because of their geo-ecological settings and fragility, heavy dependence on monsoon rains, massive deforestation, socio-economic instabilities and occurrence of natural disasters like floods, droughts, cyclones and earthquakes. The state of Assam is situated in the center of the NE region and hill states (except Sikkim) are situated around it. Assam has 68.2% of the total population against an area of 29.9% of the region. The plains mainly comprise of Brahmaputra and Barak valleys. The adjoining areas of the Brahmaputra and Barak rivers are active flood plains with marshy lands subjected to extreme annual inundation. Although it is the presence of these rivers that has led to agricultural prosperity in certain parts of the region, these, especially the Brahmaputra, are also responsible for various water-induced disasters like annual floods, flash floods, river-bank erosion, and sand casting (Das *et al.*, 2009).

5.1.2 A Brief Description of Assam /State Profile of Assam

Assam is a state situated in the North-East region of India–bordering seven states namely Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and West Bengal and two countries viz-Bhutan and Bangladesh. The geographical area of the state is 78,438 sq. km. of which 98.4 percent area is rural. Assam shares about 2.4% of the country's landmass, providing shelter to 2.6% of India's population as per Census, 2011. For administration and revenue purposes, the state has presently 35 districts, including six newly created districts namely Biswanath, Charaideo, Hojai, South Salmara, West Karbi-Anglong, Majuli, Bajali, and Tamulpur. Due to the delimitation process in Assam, four districts viz-Biswanath, Hojai, Bajali, Tamulpur are merged with their original districts.

Assam is a state of heterogeneous population with socio-cultural and ethnic diversity. According to the Census of India, 2011 the population of Assam was 312.05 lakh of which 159.39 lakh were male and 152.66 lakh were female. The projected population (released by Census of India) of Assam in 2022 is found as 353.78 lakh of which 180.06 lakh are male and 173.71 lakh are female. The decadal growth rate of the state population during 2001-2011 was 17.07% against 17.68% growth for the country as a whole. Out of the total population in the state, 86% population lived in rural areas and 14% population in urban areas. The percentage of the rural population of the state was higher than India's average (69%). However, the urban population in the state had increased from 12.9% in 2001 to 14% in 2011. The density of the population of Assam in 2011 was 398 persons per sq. km. as compared to 340 persons in 2001. The sex ratio (number of females per thousand males) of Assam had increased to 958 in 2011 from 935 in 2001. Compared to the overall sex ratio of the state, the child sex ratio (age group 0-6 years) gradually declined from 975 in 1991 to 967 in 2001 and further to 962 in 2011. On the other hand, the sex ratio at birth in Assam as per the 2011 census was 957.

State Profile of Assam	
Geographical Location-	
Latitude :	24 N° - 28 N°
Longitude :	90 E° - 96 E°
Geographical Area(Sq.Km.)	78438
Average Rainfall (in mm):2022	2402.9
Districts [Year 2023]:	33
Blocks:	219

Gaon Panchayat:	2200
Villages:	26395
Total Population [Census 2011]	31205576
Literacy Rate (%) [Census 2011]:	72.19
Land Utilization, (in ha.) [2020-21(P)]:	
Total Reported Area	7831027
Forest Area:	1828936
Area under Non-agricultural Uses:	1323955
Net Area Sown	2723610
Total Cropped Area	3888368
Area under (‘000 ha.) [2021-22(P)]:	
Rice	2360470
Wheat	9342
Maize	41157
Pulses	144
Total Food grains	2554
Total oilseeds	332
Production of (‘in Tonne) [2021-22(P)]:	
Rice	4382698
Wheat	11374
Maize	170180
Pulses	110
Total Food grains	4678
Total oilseeds	332
Number of Operational Holding ('000Nos)[2010-11]:-	
Marginal (below 1 Hectare):	1868
Small (1.0 to 2.0 Hectare):	495
Semi Medium (2.0 to 4.0 Hectare):	295
Medium (4.0 to 10.0 Hectare):	79
Large (above 10.0 Hectare):	4
Average size of Operational Holding (in Hectare):	1.09
Net Irrigated Area (in'000 Hect.):	254.45

Gross Irrigated Area (in'000 Hect.):	291.55

Source (Directorate of Economics and Economics, Govt. of Assam,2023)



Fig5.1: Map of Assam depicting the districts

The state is divided into six agro-climatic zones based on factors like topography and terrain, ecology and climate influencing land use pattern, crop mix, cropping intensity and crop productivity. The agro-climatic zones are (i) Barak Valley Zone (ii) Central Brahmaputra Valley Zone (iii) Lower Brahmaputra Valley Zone (iv) North Bank Plain Zone (v) Upper Brahmaputra Valley Zone and (vi) Hills Zone of Assam. The study was undertaken in the Dhemaji district under the North Bank Plain Agro-Climatic Zone of Assam.

5.1.3 Description of North Bank Plain Agro-Climatic Zone

The zone comprises three districts, viz. Lakhimpur, Sonitpur, and Darrang (presently six districts, Dhemaji, Lakhimpur, Biswanath, Sonitpur, Udalguri, and Darrang. The zone is primarily agrarian in character.

5.1.3.1 Physiography

The zone has undulating topography and it has been delineated into five physiographic variations, viz. (i) Foothill belt along Arunachal Pradesh, (ii) Old Flood Plain (upper terrace) representing northern belt of flood plain (iii) Old Flood Plain (lower terrace) spreading southern boundary of the middle plain, (iv) Recent Flood Plain representing low lying active flood plain of the river Brahmaputra and its tributaries and (v) Marshes and swamps known as *beels* which remain perennially waterlogged.

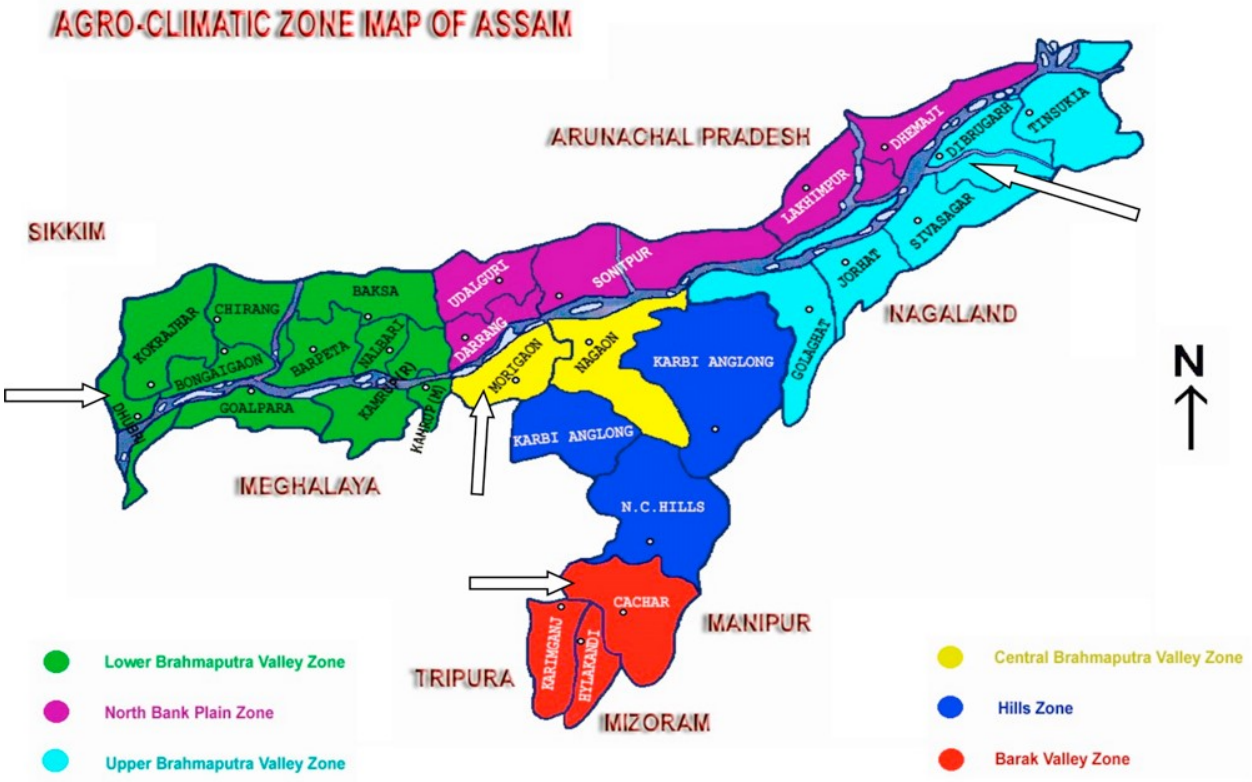


Fig5.2: Map of Assam depicting the Agro-Climatic Zone

5.1.3.2 Soils

The zone has alluvial soil and the chief characteristics of the soils are acidic in nature. The soils are classified as (i) Old Alluvial soils (Alfisols), (ii) Old Alluvial Soils (Inceptisols) and (iii) New Alluvial Soils (Entisols), Alfisols along the foothills in the northern side of the zone are rich in organic matter with low to medium potash being covered by forest vegetation and tea plantation in patches. It has a higher potential on the southern side of the belt. Inceptisols are newer than the foothill soils and lie in the middle plains of the old flood plain valley of the zone. Soil texture ranges from sandy loam-to-loam, silty clay loam, silty clay and clay. The soils are silt in organic matter and acidic in nature. These soils are used extensively for the cultivation of *ahu* rice and *sali* rice. Entisols are distributed along the riverine tract of the Brahmaputra and its major tributaries. The texture of the soil is coarse with sandy-to-sandy loam near the rivers and sandy loam-to-loam from the active river belt. The low-lying

riverine tracts are poorly drained. The soil is rich in organic matter. The zone is suitable for *ahu, sali* and *bao* rice as well as jute. Crops like rapeseeds and mustard, wheat, pea and other pulses are also grown in the low-lying areas.

5.1.3.3 Climate

The climate of the zone is sub-tropical humid characterized by high rainfall, which varies from 1500mm in the western part to 3400mm in the north-eastern part of the zone. The distribution of rainfall in the zone is quite uneven. As a result, the crops grown in the zone suffer from water stress conditions in some months and without irrigation, productivity is also affected. The temperature varies from 22'C to 35oC with a mean relative humidity of 81 percent.

5.1.3.4 Land Use Pattern

The gross cropped area of the zone is 49.60 percent of the total geographical area and permanent pasture and grazing, miscellaneous trees and grooves and total fallow land consist of 3.14, 2.86 and 1.35 percent respectively. Cultivable wasteland is 4.30 percent while 39 percent of the total cropped area is double cropped.

5.1.3.5 Agro-ecological situations

North Bank Plain zone has eight agro-ecological situations, viz., (i) Medium land with Medium Rainfall (ii) Medium Land with High Rainfall (iii) Low Land Situation with Lower elevation (iv) Deepwater situation with Lower Elevation, (v) riverine Situation with Lower Elevation, (vi) Upland with Medium Rainfall, (vii) Upland with High Rainfall and (viii) Foot Hill Situation with Higher Elevation.

Except for rainfall, the characteristics of the first two situations are almost the same. In situation (i) Cropping intensity varies from 156 to 172 percent while it is 142 percent in situation (ii). The common crops grown are cereals, pulses, oilseeds, jute, sugarcane, sesamum etc. The plantation crops are banana, pineapple, citrus fruits and papaya. In the low land situation, the soil texture is loam, silty loam, clay loam and clay. The soil remains submerged for about 4 months. Rice is the main crop and the other crops are wheat, pulses, jute, vegetables and spices. The cropping intensity ranges between 126 to 146 percent. The situation is suitable for rice cum fish culture. The Deep-water situation is rich with organic matter and the soil texture varies from sandy loam to clay loam with medium rainfall.

Deep-water rice is the dominating crop followed by *ahu* and *boro* rice. Other crops are rapeseed and mustard, pulses, wheat, vegetables and jute. The average cropping intensity varies from 118 to 130 percent and the situation is suitable for rice cum fish culture. Situation (v) is spread over 74,680 hectares formed in the recent flood plain of river Brahmaputra and

its tributaries known as *Char* land. The new alluvial soil is formed by sandy loam to silty loam texture. In this situation also rice is the dominant crop followed by rapeseeds, pulses, wheat, potato, vegetables, spices, groundnut, niger. Deep-water rice is more dominating. Cropping intensity varies from 110 to 162 percent. In situations (vi) and (vii) the soil textures are mostly sandy loam, silty loam, silty clay and clay. Upland crops occupy relatively more area. Other crops are oilseeds, pulses, wheat, potato, vegetables, spices, maize and other minor crops. Horticultural plantation crops are coconut, Assam lemon, banana, pineapple and papaya. In situation (vii) banana and agro-forestry cover a sizeable area. The cropping intensity in the medium rainfall situation is higher (152%) than in the high rainfall situation (127%). In the Foothill situation, the soils are mostly alluvial in nature with a medium texture comprising sandy loam to clay loam with medium rainfall. Rice is the main crop followed by potato, maize, vegetables, oilseeds, pulses, castor and major spices. Agro-forestry is also prominent while horticultural plantation crops like bananas and pineapple are more potential crops in this situation. (Anonymous, 1999)

5.1.4 A brief description of Dhemaji district

Dhemaji District is situated in the remote corner of North East India on the north bank of the river Brahmaputra. The boundaries of the district are the hilly ranges of Arunachal Pradesh to the North and the East, the Lakhimpur district to the West and the river Brahmaputra in the South. It is located at an altitude of 98.75 MSL and 94°12′18″ E and 95041′32″ E longitude, and 27°05′27″ N and 27o57′16″ N latitude. The river Brahmaputra flows from east to west in the southern part of the district. Different tributaries viz, Dihingia, Jiadhal, Moridhal, Telijan, Kaitongjan, Laipulia Nadi, Kapurdhuwa, Sissi, Gai, Tangani and Guttong originating from Arunachal Pradesh in the north, flow southwest carrying an enormous amount of alluvium through the district before meeting the river Brahmaputra. The district is vulnerable to floods and occurrences of floods are a regular feature, which causes a lot of damage. Nearly 27% of the net cropped is flood-prone as well as flood-affected. The soil of the district is mainly alluvial and sandy.

The total geographical area of the district is 3237 sq. km out of which 3221.45 sq. km is rural and 15.55 sq. km is urban (Census 2011) which 36.16% is cultivable, 0.8% is cultivable wasteland, 0.8% is current fallow, 4.94% forest, 6.08% pasture, 8.1% under non-agricultural use, 3.70% under miscellaneous plantation. As per the statistical handbook of Assam-2014, the Net Sown Area of Dhemaji is 67506 hectares and the total cropped area is 121227 hectares.

Agriculture is the main occupation of the people engaging about 59% of the working population. Paddy is the major agricultural crop cultivated in 69290 ha (summer, autumn and winter paddy), constituting around 55% of the gross cropped area (2001-2002). Mustard is the major oil seed crop grown in the district. Potato and pulses are other major crops grown in the district. Fruits and vegetables are also cultivated on a moderate scale. Piggery, Dairy and Goat rearing are the major allied agricultural activities carried out in the district. Apart from Agriculture and allied activities, Sericulture activity especially muga rearing is gaining ground. Industrial activity is not prominent in the district and no major industrial units exist in the district. There are around 248 SSI units registered with the District Industries and Commerce Centre (DICC).

5.1.4.1 Administrative structure

For administrative purposes, the entire district is divided into two Subdivisions viz Dhemaji and Jonai Sub-Division. Again each sub-division is divided into revenue circles and under revenue circles there are *Mouzas* comprising revenue villages The Dhemaji district consists of 6 revenue circles viz. Dhemaji, Sissiborgaon, Dhakuakhana (Pt), Jonai, Subansiri (Pt) and Gogamukh Revenue Circles which cover 1319 numbers of Villages. Out of the total villages, 55 numbers of villages are uninhabited. There are 2 statutory towns and 2 census towns. There are five Community Development blocks namely Bordoloni, Dhemaji, Machkhowa, Sissiborgaon and Murkongselek. The district covers an area of 3237 sq. km. (Rural: 3221.45 sq. km and Urban: 15.55 sq. km).

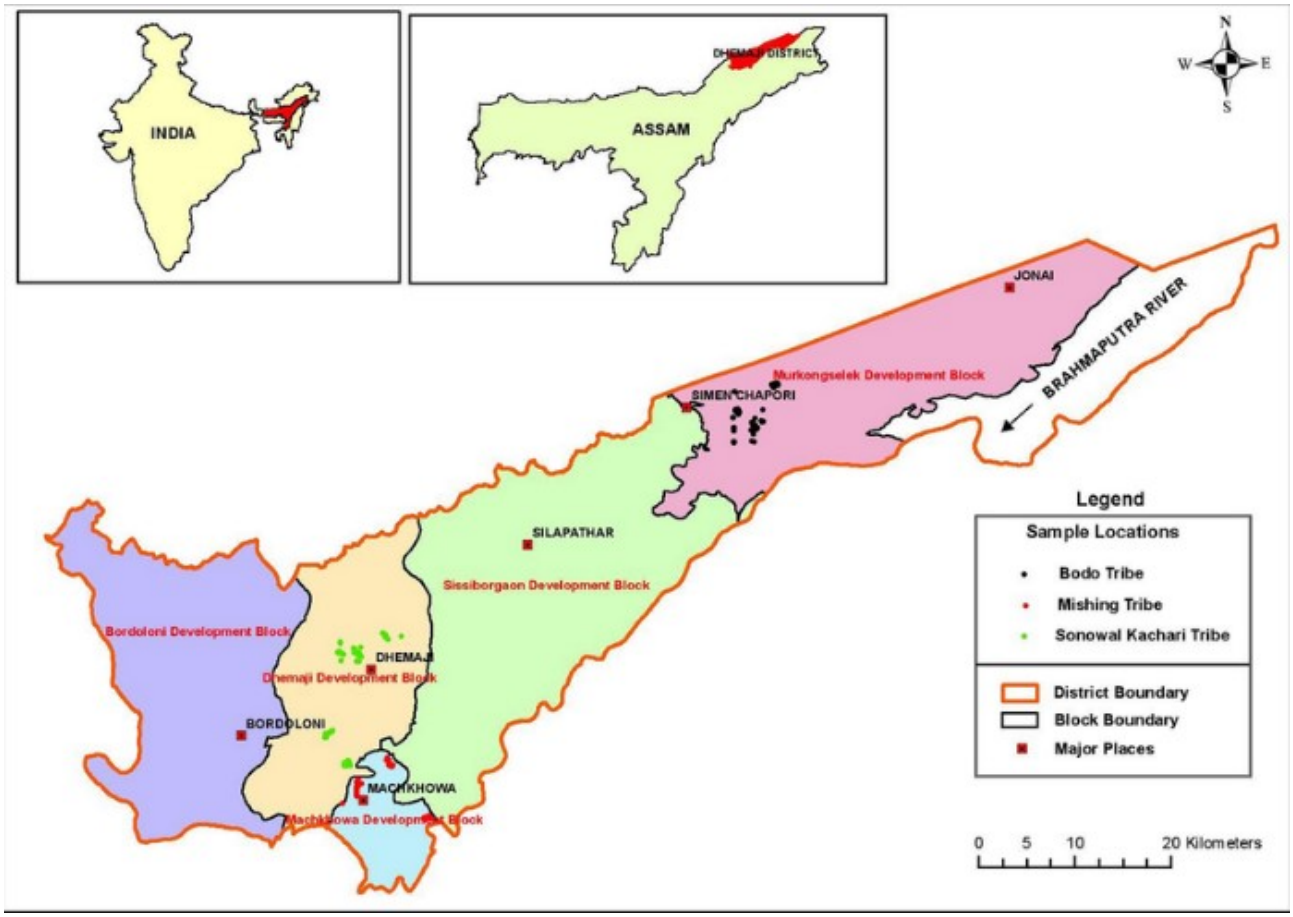


Fig5.3: Map of Dhemaji district depicting the Community Development Block

5.1.4.2 Demography

As per the 2011 census, the total population of Dhemaji is 686133 with a density of population 212 per sq. km, which is lower than the state average of 398. The decadal variation of the population for 2001-2011 is 19.97 percent, which is high as compared to other districts of Assam. The overwhelming majority of people in Dhemaji live in the villages. The district is predominantly rural with 92.96 percent of the total population in the district is residing in rural areas while the urban population is 7.04 percent which is lower than the state average of 14.1 percent. According to census 2011, the sex ratio in the district is 953 females per 1000 males, which is lower than the state average of 958. The sex ratio in rural and urban Dhemaji is 955 and 934 per 1000 males respectively. Therefore, it shows that the sex ratio in rural areas is higher than in urban areas of the district. The total number of households in the district is 129504.

Like the trend in the country, men predominate the main worker's category both in rural and urban. While women outweigh men in the marginal workers category both in rural as well as urban areas. The working females in rural Dhemaji are mostly marginal workers. So far as the literate population is concerned, with 72.70 percent of the average literate population,

including 79.84 percent literate males and 65.21 percent literate females, the district has a higher literacy rate as compared to the state. The rural-urban differential indicated by higher literacy for rural males (56.37%) and urban women (45.59%) highlight a wide disparity in literacy of rural and urban population, especially the deprivation of the rural women with only 43.63 percent literacy rate while urban male literacy rate is 54.41 percent (Census 2011).

5.1.4.3 Landholding and Land Use Pattern

Agriculture in Dhemaji is characterized by small holdings operated by family labour, both men and women. The average land holding size in Dhemaji is 0.95 ha. However, small & marginal farmers and landless, who make up 89 % of landholders, have an average farm size of 0.57 ha. The net sown area of the district is 109677.17 ha which accounts for 58.32 percent of the geographical area of the district & the land utilization pattern in the district. The gross cropped area of the district is 156681.70 ha with a cropping intensity of 143 percent. Out of the total cropped area, 47004.50 ha and 30 percent are used more than once.

5.1.4.4 Agro-Ecology, Rainfall and soil profile,

ATMA, Dhemaji identified five agro-ecological situations (AES)in the district on the basis of rainfall, physiography, soils, floods etc., These 5 agro-ecological situations (AES) are (i) Foothill (AES-I), (ii) Low and Flood affected (AES-II), (iii) Sand deposited area (Coarse) (AES-III), (iv) Medium land (AES-IV), and (v) Sand deposited area (Fine silt) (AES-v). The AES-IV (Medium land) has the highest area visually 156682 ha (52%) followed by AES-II (Low and Flood affected) with 63275 ha (21%), AES-I (Foothill) with 61769 ha (20.5%), AES-III (Sand deposited area (Coarse)) with 10546 ha (3.5 %) and AES-V (Sand deposited area (Fine silt)) with 9039 ha (3.0%).

The district experiences a sub-tropical climate with experience of mild winters and warm and humid summers. The weather conditions are framed by the influences of both the North–East and South–West Monsoon. There is marked variation in weather situation in different months, on the basis of which it is classified into Winter Season (December to February), Pre-Monsoon Season (March to May), Monsoon (June to September) and Post Monsoon (October and November). As the major part of the area is located near the foothills of Arunachal Pradesh, it exhibits differences in temperature, rainfall, fog, wind etc. The climate of the area is pre-humid characterized by high rainfall, mild summer and winter and falls under a cool to warm pre-humid thermic-agro-ecological sub zone. The annual rainfall of the district ranges from 1871.50 mm to 2882.30 mm. Rainfall generally begins in April and continues till the end of September. The average monthly rainfall in the district is 1228 mm.

On an average, there are about 156-170 days of rain in a year. The relative humidity varies from 70 to 90 per cent.

The general and average soil character of cultivable land in these districts is mainly alluvial and composed of a mixture of sand (coarse to fine) and clay in varying proportions. The general geochemical characteristic of the soil is highly acidic. However, new alluvial soils formed due to inundation of land by the river at intervals contain more percentages of fine sand and fine silt and are less acidic. Such soils are often neutral and even alkaline. The large expanse of low-lying land characterized by heavy clayish soil with a high percentage of nitrogen is good for rice cultivation. Abundant rainfall and excessive humidity throughout the year also greatly favor the cultivation of rice in the district. The soil around the Subansiri and Ranganadi rivers is sandy coated with silt which is good for the cultivation of winter crops, such as raga, and mustard, potato etc. Out of the total geographical area, 9.08% area is clay soil, 20.24% of clay loam, 4.42% of alluvial, 20.61% of sandy soil and 45.65% of sandy loam soil type. The soils of this district can be broadly classified into three different zones viz. The foothill soils, active floodplain soils near the river Brahmaputra and the low-lying marshy lands.

Dhemaji District Profile	
Geographical location:	
1. GPS Coordinates:	940 12’ 18” E & 950 41’ 32”E 270 07’ 27”N & 270 57’ 16”N
2. Height from MSL:	98.75 m (Avg.)
3. Location:	The easternmost corner of Assam
4 Boundary:	East- Arunachal Pradesh West- Lakhimpur district and the river Subansiri North- Arunachal Pradesh South – The River Brahmaputra
5 Agro Climatic Zone, Assam:	North Bank Plain Zone
Land Use Pattern	
1. Total Geographical area:	3,23,695 ha
2. Total cultivable area:	1,12,170 ha (34.65% of total geo. area)
3. Net cropped area:	97,208ha
4. Gross cropped area:	1,06,634 ha
5. Cultivable fallow land:	12,490 ha
6. Non cultivable waste land:	10,430 ha

7. Forest and grazing:	53,224 ha
8. Sand deposited and silted areas:	22,546 ha
9. Water bodies including water logged areas:	44,136 ha
10. Area under irrigation:	7,426 (6.6% of total cultivable area)
11. Cropping intensity:	144%
12. Fertilizer consumption:	1.84ka/ha

(Source-KVK,Dhemaji)

5.2 Micro-Research Setting

5.2.1 Brief about the selected Blocks

The Dhemaji district has 5 Community Development Blocks and Murkong Selek and Machkhowa Blocks were selected for the study. A brief description of each block is presented below:

The Murkong Selek Tribal Development Block was established in 1958. The boundary of the Machkhowa Development Block consists of Arunachal Pradesh State in the North and East direction, Sisiborgao Development Block in the in East, and the river Brahmaputra in the South. The Murkong Selek Tribal Development Block has an area of 1111.81 sq. kilometer. It comprises 15 village panchayats and 273 revenue villages. The total population of the Block is 1, 60,091 with 82,127 male and 77,964 female populations. The literacy rate of the Block is 64.88 % (male-72.69 % and female 56.69 %). Moreover, the Block has 71.09 % ST and 2.13 % SC population out of the total population of the Block. The distance of the Murkong Selek Tribal Development Block from the district headquarters is 91.80 km.

Murkong Selek Tribal Development Block Profile	
Established	2nd October,1958
Total Geographical area	1111.81 sq. kilometer 33191.98 ha
Total Population	1,60,091(Census,2011)
Male Population	82,127
Female Population	77,964
ST Population	113816 (71.09%)
SC Population	3409 (2.13%)
Revenue Village	273 nos.
Gao Panchayat	15 nos.
Population per sq km	127.58
Literacy Rate(Census,2011)	64.88 %

Literacy Rate(Male)	72.69 %
Literacy Rate(Female)	56.69%
Annual Average Rainfall	3013.21mm
Forest Area	43,748.96 ha
Agricultural Land	39,995 ha
Land under Cultivation	34,045 ha
Land under Cultivation more than once	5,950 ha
Veterinary Dispensary	3 nos
Health Services(CHC,PHC,MHC,HSC)	28 nos
Educational Institute (college and all schools)	633 nos
Commercial Bank	6 nos
Cooperative Society	41 nos
Market	18 nos

(Source-www.dhemaji.nic.in, District Census Report, Dhemaji 2011)

The Machkhowa Development Block was established in 1990. The boundary of the Machkhowa Development Block consists of Dhemaji Development Block in the North, Sisiborgao Development Block in the in East, Lakhimpur district in the west and the river Brahmaputra in the South. The Machkhowa Development Block has an area of 76.87 sq km . It comprises of five village panchayat and 51 revenue villages. The total population of the Block is 29,575(male14825 and female 14750). The literacy rate of the Block is 76.26% with 82.97 % male and 69.52% female literacy rate. Moreover, the Block has 45.34% ST and 6.53% SC population out of the total population of the Block. The distance of the Machkhowa Development Block from the district headquarter is 9 km.

Machkhowa Development Block Profile	
Established	19th February,1990
Total Geographical area	76.87 Sq Km
Total Population	29,575(Census,2011)
Male Population	14825
Female Population	14750
ST Population	13410 (45.34%)
SC Population	1932 (6.53%)
Revenue Village	51 nos.
Gao Panchayat	5 nos.
Population per sq kilometer	100(2001, Census)

Literacy Rate(Census,2011)	76.26%
Literacy Rate(Male)	82.97 %
Literacy Rate(Female)	69.52%
Annual Average Rainfall	2700.4 mm
Land under Cultivation	34,045 ha
Land under Cultivation more than once	5,950 ha
Veterinary Dispensary	2 nos
Health Services(BEHC,MHC,HSC)	31
Educational Institute (college and all schools)	102 nos
Commercial Bank	2 nos
Cooperative Society	72 nos
Market	3

(Source-www.dhemaji.nic.in, District Census Report, Dhemaji 2011)

5.2.2 A brief about the selected villages

A total of eight villages namely Lamajan Mising, Madhabpur, No 2 Narayanpur and No 2 Nawkata under Murkong Selek Tribal Development Block and Rajabari Gao, Seujia Pathar, Khalihamari Na- Pamua and Solmara Gaon from under Machkhowa Development Block are selected randomly to carry out this study.

Lamajan Mising

According to Census 2011 information the location code or village code of Lamajan Mising village is 289295. Lamajan Mising village is located in Jonai subdivision of Dhemaji district in Assam, India. It is situated 8km away from sub-district headquarter Jonai (tehsildar office) and 65km away from district headquarter Dhemaji. As per 2009 statistics, Somkong is the gram panchayat of Lamajan Mising village. The total geographical area of the village is 64 hectares. Lamajan Mising has a total population of 328 people, out of which the male population is 167 while the female population is 161. The literacy rate of Lamajan mising village is 46.34% out of which 52.10% males and 40.37% females are literate. There are about 58 houses in Lamajan mising village. The pin code of Lamajan Mising village locality is 787061. Silapathar is the nearest town to Lamajan Mising for all major economic activities, which is approximately 32km away.

Madhabpur

According to Census 2011 information the location code or village code of Madhabpur village is 289415. Madhabpur village is located in Jonai subdivision of Dhemaji district in Assam, India. It is situated 26km away from sub-district headquarter Jonai (tehsildar office) and 95km away from district headquarter Dhemaji. As per 2009 stats, Laimekuri is the gram

panchayat of Madhabpur village. The total geographical area of the village is 71 hectares. Madhabpur has a total population of 304 people, out of which the male population is 151 while the female population is 153. The literacy rate of Madhabpur village is 45.07% out of which 52.98% of males and 37.25% of females are literate. There are about 50 houses in Madhabpur village. The pin code of Madhabpur village locality is 787060. Pasighat is the nearest town to Madhabpur for all major economic activities, which is approximately 62km away.

No. 2 Narayanpur

According to Census 2011 information the location code or village code of No 2 Narayanpur village is 289308. No 2 Narayanpur village is located in Jonai subdivision of Dhemaji district in Assam, India. It is situated 6km away from sub-district headquarter Jonai (tehsildar office) and 57km away from district headquarter Dhemaji. As per 2009 stats, Somkong is the gram panchayat of No 2 Narayanpur village. The total geographical area of the village is 161.72 hectares. No 2 Narayanpur has a total population of 294 people, out of which male population is 153 while female population is 141. The literacy rate of no 2 Narayanpur village is 64.97% out of which 76.47% males and 52.48% females are literate. There are about 50 houses in no 2 Narayanpur village. Silapathar is the nearest town to no 2 Narayanpur for all major economic activities, which is approximately 33km away.

No. 2 Nawkata

According to Census 2011 information the location code or village code of No 2 Nawkata village is 289328. No 2 Nawkata village is located in Jonai subdivision of Dhemaji district in Assam, India. It is situated 10km away from sub-district headquarter Jonai (tehsildar office) and 40km away from district headquarter Dhemaji. As per 2009 stats, Missamora is the gram panchayat of No 2 Nawkata village. The total geographical area of the village is 26.44 hectares. No. 2 Nawkata has a total population of 255 people, out of which the male population is 127 while the female population is 128. The literacy rate of No. 2 Nawkata village is 50.20% out of which 62.99% males and 37.50% females are literate. There are about 45 houses in no 2 Nawkata village. Jonai is the nearest town to No. 2 Nawkata village for all major economic activities.

Rajabari

According to Census 2011 information the location code or village code of Rajabari village is 289663. Rajabari Gaon village is located in Dhakuakhana subdivision of Dhemaji district in Assam, India. It is situated 4km away from sub-district headquarter Dhakuakhana (tehsildar office) and 25km away from district headquarter Dhemaji. As per 2009 stats, Jorkata is the

gram panchayat of Rajabari Gaon village. The total geographical area of the village is 128.53 hectares. Rajabari Gaon has a total population of 358 people, out of which the male population is 184 while the female population is 174. The literacy rate of Rajabari village is 67.32% out of which 67.39% of males and 67.24% of females are literate. There are about 84 houses in Rajabari Gaon village. The pin code of Rajabari gaon village locality is 787058. Dhakuakhana is the nearest town to Rajabari Gaon village for all major economic activities.

Seujia Pathar

According to Census 2011 information the location code or village code of Seujia Pathar village is 289651. Seujia Pathar village is located in Dhakuakhana subdivision of Dhemaji district in Assam, India. It is situated 33km away from district headquarter Dhakuakhana. Dhakuakhana is the sub-district headquarter of Seujia Pathar village. As per 2009 stats, Pub Machkhowa is the gram panchayat of Seujia Pathar village. The total geographical area of the village is 198.44 hectares. Seujia Pathar has a total population of 304 people, out of which the male population is 146 while the female population is 158. The literacy rate of Seujia pathar village is 79.93% out of which 83.56% of males and 76.58% of females are literate. There are about 69 houses in Seujia pathar village. The pin code of Seujia pathar village locality is 787058. Dhemaji is the nearest town to Seujia pathar for all major economic activities, which is approximately 35km away.

Khalihamari Na- Pamua

According to Census 2011 information the location code or village code of Khalihamari Na Pamua village is 289667. Khalihamari Na-Pamua village is located in Dhakuakhana subdivision of Dhemaji district in Assam, India. It is situated 3km away from sub-district headquarter Dhakuakhana (tehsildar office) and 35km away from district headquarter Dhemaji. As per 2009 stats, Jorkata is the gram panchayat of Khalihamari Na Pamua village. The total geographical area of the village is 331.83 hectares. Khalihamari Na Pamua has a total population of 966 people, out of which the male population is 476 while the female population is 490. The literacy rate of Khalihamari Na-Pamua village is 62.32% out of which 69.33% of males and 55.51% of females are literate. There are about 164 houses in Khalihamari Na-Pamua village. The pin code of Khalihamari Na-Pamua village locality is 787058. Dhakuakhana is the nearest town to Khalihamari Na-Pamua village for all major economic activities

Solmara

According to Census 2011 information the location code or village code of Solmara village is 289648. Solmara Gaon village is located in Dhakuakhana subdivision of Dhemaji district in

Assam, India. It is situated 2km away from sub-district headquarter Dhakuakhana (tehsildar office) and 25km away from district headquarter Dhemaji. As per 2009 stats, Jorkata is the gram panchayat of Solmara Gaon village. The total geographical area of the village is 111.25 hectares. Solmara Gaon has a total population of 399 people, out of which the male population is 205 while the female population is 194. The literacy rate of Solmara village is 77.69% out of which 85.85% of males and 69.07% of females are literate. There are about 74 houses in Solmara Gaon village. The pin code of Solmara Gaon village locality is 787085. Dhakuakhana is the nearest town to Solmara Gaon village for all major economic activities.

CHAPTER-6



RESULTS AND DISCUSSION

This chapter deals with the results to be presented and interpreted from the data collected, systematically arranged, classified and analyzed in the light of the study. The results and discussion thereon of the empirical and descriptive analyses are presented in this chapter under the following heads.

PART-A

6.1 Attributes of farmers in the study area

6.2 Computation of Farmer Disaster Resilience Index

6.3 Factors associated with the Farmer resilience index

6.4 Agricultural extension needs of Farmer for disaster resilience

6.5 Challenges associated with farmers' agricultural extension needs and disaster resilience

6.6 Strategic paradigm for farmers' agricultural extension needs and disaster resilience

6.7 Accepted Hypothesis

PART-B

1. Success Story-A
2. Success Story-B
3. Success Story-C

PART-A

6.1 The attributes of farmers in the study area

6.1.1Socio-personal attributes

6.1.1.1 Age

Table 6.1: Distribution of the respondents according to their age(X_1) n=200

Category	Age	Frequency	Percentage	Statistics
Young aged	<32	42	21.00	Range = 26-73
Middle aged	32 - 61	118	59.00	Mean =46.55
Old aged	>61	40	20.00	SD =14.59
				CV =31.34%

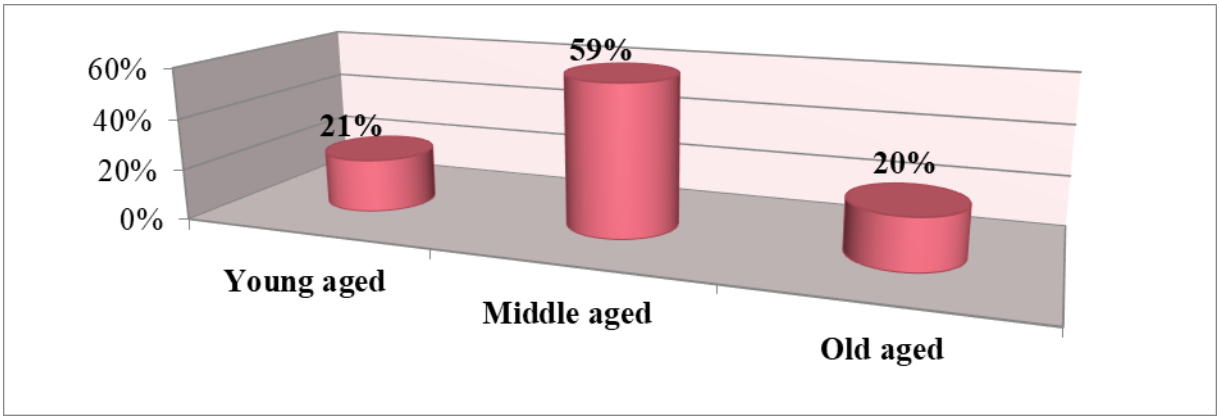


Fig. 6.1: Diagrammatic representation of the respondents according to their age(X_1)

Table 6.1 presents and Fig. 6.1 depicts the distribution of the farmers according to their age. The results show that the majority of the respondents (59%) are under the age group of 32-61 years followed by <32 years age group (21%) and > 61 years age group (20%) respectively. The mean score of the total distribution, age is 46.55 and the standard deviation of the distribution is 14.59. The coefficient of variation value within the distribution of 31.34 percent signifies the high consistency level of the distribution for the variable 'age'. It is indicative that mostly middle-aged rural people are associated with farming activities in the Dhemaji district of Assam.

6.1.1.2 Family education status

Table 6.2: Distribution of the respondents according to their family education status(X_2) n=200

Category	Education status	Frequency	Percentage	Statistics
Low	<2.24	26	13.00	Range = 1-5
Medium	2.24 - 3.62	149	74.50	Mean =2.93
High	>3.62	25	12.50	SD =0.69
				CV =23.54%

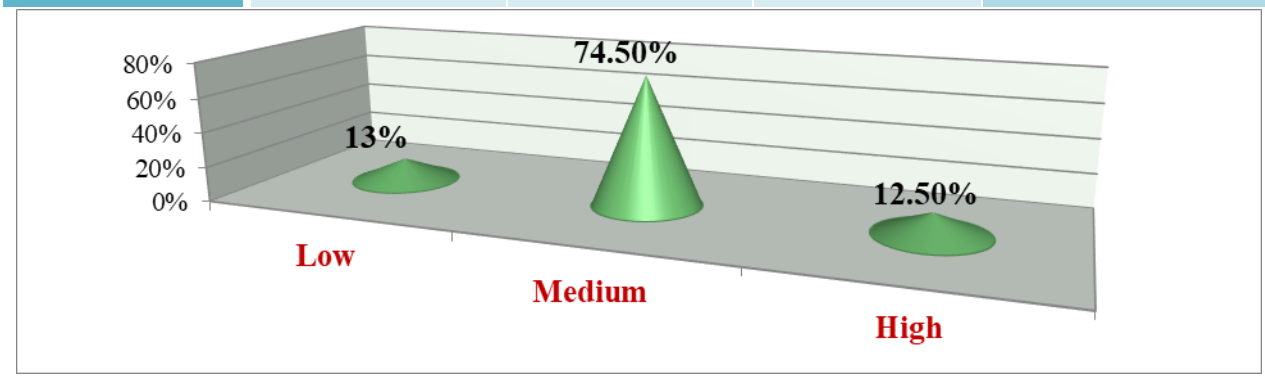


Fig.6.2: Diagrammatic representation of the respondents according to their family education status(X_2)

Table 6.2 and Fig. 6.2 show the distribution of the farmers according to their family education status. The results indicate that most of the respondent's family education status falls under medium family education status (74.50%) followed by the low education status category (13 %) and high education status category (12.5) respectively. The mean score of the total distribution, family education status is 2.93 and the standard deviation of the distribution is 0.69. The coefficient of variation value within the distribution of 23.54 percent signifies the high consistency level of the distribution for the variable 'family education status'. It is indicative that most of the respondents in the study area belong to medium family education status.

6.1.1.3 Farming experience

Table 6.3: Distribution of the respondents according to their farming experience(X_3) n=200

Category	Farming experience	Frequency	Percentage	Statistics
Low	<10	20	10.00	Range = 5-55
Medium	10 - 39	126	63.00	Mean =24.48
High	>39	54	27.00	SD =14.52
				CV =59.32%

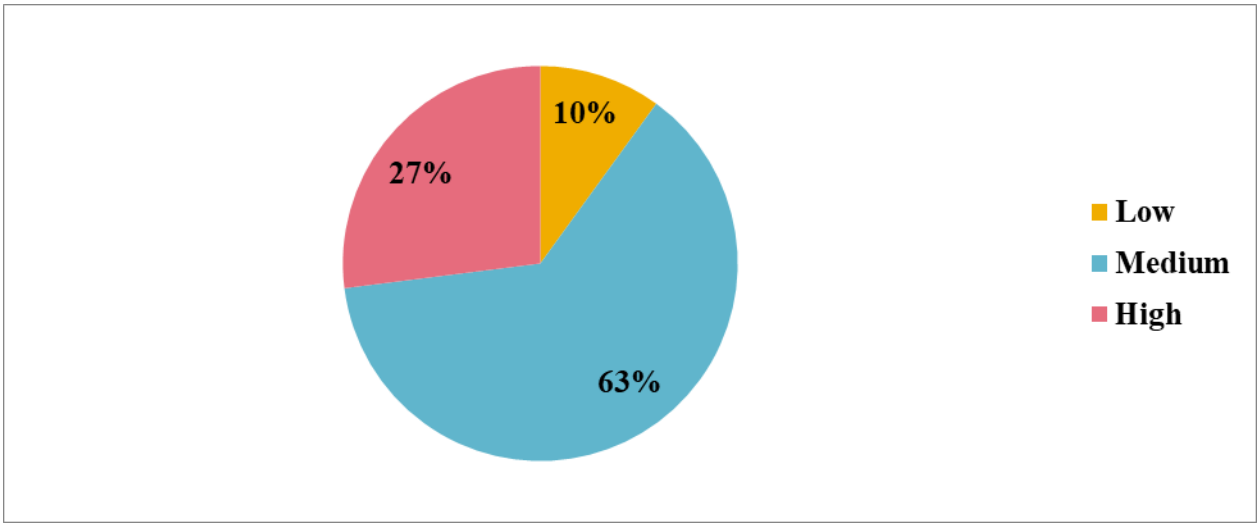


Fig.6.3: Diagrammatic representation of the respondents according to their farming experience(X_3)

Table 6.3 and Fig. 6.3 present the distribution of respondents according to their farming experience. The findings presented in Table reveal that the majority of the respondents (63.00%) have medium level (10-39 years) farming experience followed by 27.00 percent respondents

with high level or long-term experience (above 39 years). Only 10 percent of the respondents have low level or short term farming experience (less than 10 years). The mean value (24.48 years) indicates that on an average the respondents belonged to medium term experience category with standard deviation of 14.52. The coefficient of variation value within the distribution 59.32 percent signifies the low consistency level of the distribution for the variable 'farming experience'. It is indicative that most of the respondents in the study area belong to medium farming experience category. It is observable that experience of the farmers in farming is in medium level with full enthusiasms and energy to cope the discourses of farm disasters.

6.1.1.4 Family size

Table 6.4: Distribution of the respondents according to their family size(X_4) n=200

Category	Family size	Frequency	Percentage	Statistics
Small	<4	24	12	Range = 2-11
Medium	4 - 7	119	59.5	Mean =5.11
Big	>7	57	28.5	SD =1.80
				CV =35.27%

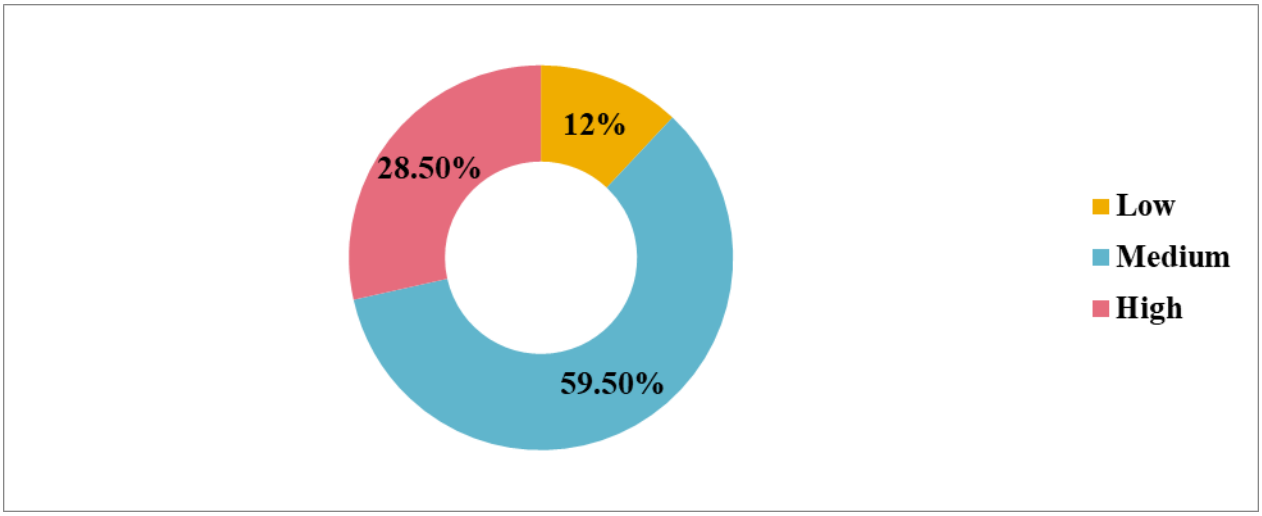


Fig. 6.4: Diagrammatic representation of the respondents according to their family size(X_4)

Table 6.4 and Fig. 6.4 present the distribution of respondents according to their family size. Among the total respondents, the majority of the respondents belong to the family comprising of 4-7 members which means medium size family (59.50%) followed by greater than 7 members means big size family (28.5%) and less than 4 members means small family (12%). The distribution of respondents ranges from a family with 2-11 members with a mean family size of

5.11 members and a standard deviation of 1.80. The coefficient of variation value within the distribution 35.27% which implies a high level of consistency. It is predicted that the perceptual expression of the respondents from the 4-7 members' family can help appropriately depict the extremities of farm disaster resilience.

6.1.2 Socio-economic attributes

6.1.2.1 Size of operational land holding

Table 6.5: Distribution of the respondents according to their size of operational land holding(X_5) n=200

Category	Size of operational land holding	Frequency	Percentage	Statistics
Low	<1.24	34	17	Range=0.8-4.7
Medium	1.2 - 3.2	127	63.5	Mean=2.26
High	>3.28	39	19.5	SD=1.02
				CV=45.13%

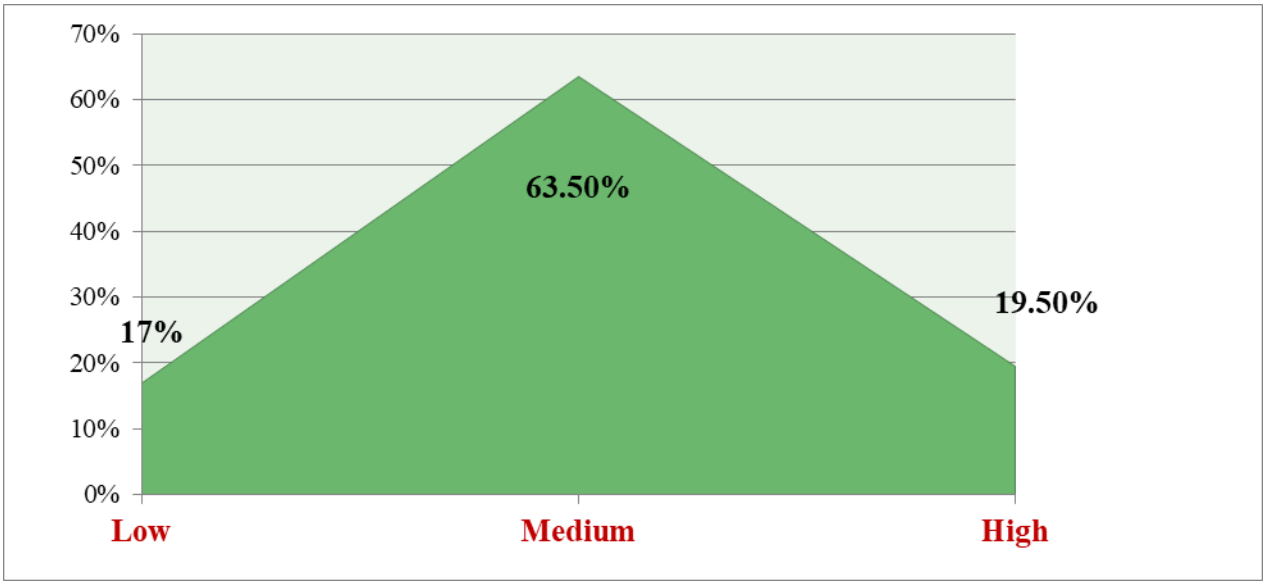


Fig.6.5: Diagrammatic representation of the respondents according to their size of operational land holding(X_5)

Table 6.5 and Fig. 6.5 present the distribution of respondents according to size of land holding. Among the total respondents, majority belonging to the group of 1.2-3.2 ha that means medium land holding (63.50%) followed by greater than 3.28 ha that means high land holding (19.50%) and less than 1.24 ha land holding that means small land holding (17%) category. The distribution of respondents is ranging from 0.8 – 4.7 ha with a mean land holding of 2.26 ha and

a standard deviation of 1.02. The coefficient of variation of total distribution is 45.13% which implies a very medium level of consistency. The variable size of land holding depicts the economic status of the family to enjoy the prestige of the family in society. The medium level of land holding status in the present study can help in depicting the extremities of farm disaster resilience.

6.1.2.2 Cropping intensity

Table 6.6: Distribution of the respondents according to their cropping intensity(X_6) n=200

Category	Cropping intensity	Frequency	Percentage	Statistics
Low	<100.10%	32	16.0	Range=1.01-1.64
Medium	100.10%- 136.00%	131	65.5	Mean=1.23
High	>136.00%	37	18.5	SD=0.133
				CV=10.62%

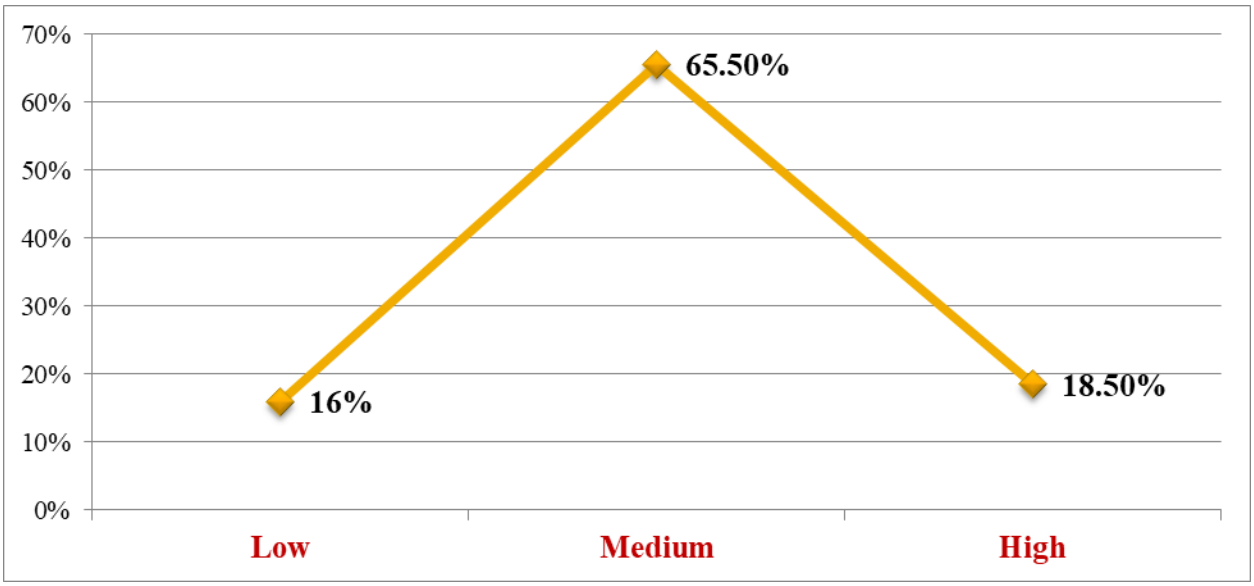


Fig.6.6: Diagrammatic representation of the respondents according to their cropping intensity(X_6)

Table 6.6 and Fig. 6.6 present the distribution of respondents according to cropping intensity. Among the total respondents, majority belonging to the group of 110-136% cropping intensity that means medium cropping intensity (65.50%), followed by greater than 1.36% that means high cropping intensity (18.50) and less than 1.1% that means low cropping intensity (16%) category. The distribution of respondents is ranging from 1.01–1.64% with a mean of 1.23% cropping intensity and a standard deviation of 0.13. The coefficient of variation of total

distribution is 10.62% which implies a very high level of consistency. The medium level of cropping intensity in the present study can help in depicting the extremities of farm disaster resilience.

6.1.2.3 Annual income

Table 6.7: Distribution of the respondents according to their annual income(X_7) n=200

Category	Annual income (Rs in Lac)	Frequency	Percentage	Statistics
Low	<1.15	34	17	Range=0.7-5.2
Medium	1.15 - 2.87	127	63.5	Mean=2.01
High	>2.87	39	19.5	SD=0.86
				CV=42.78%

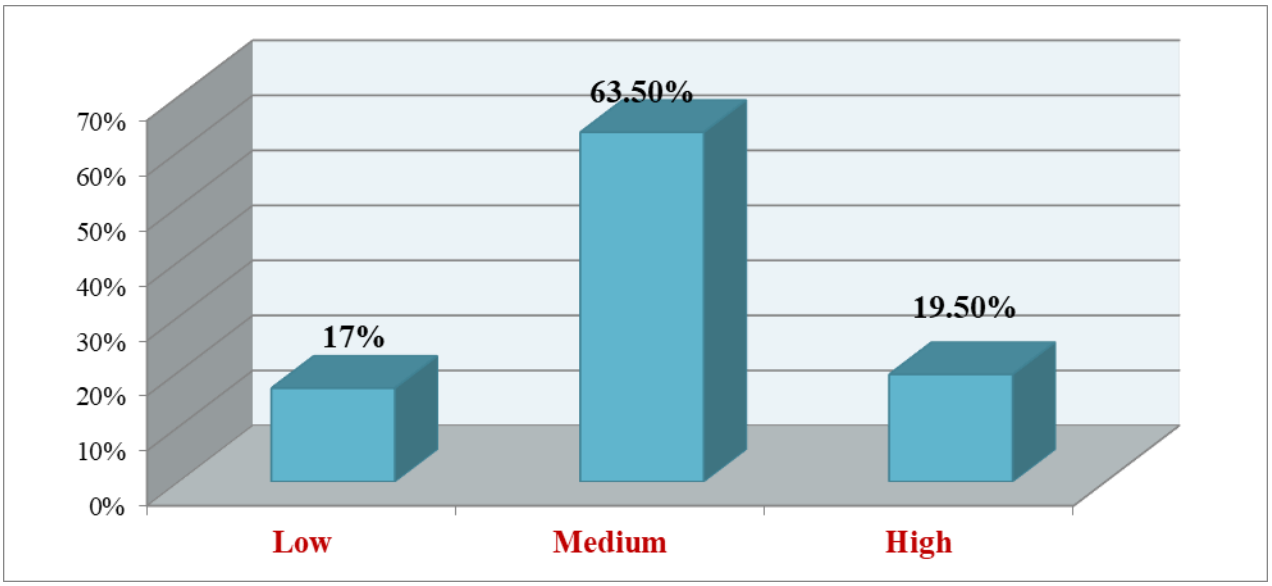


Fig.6.7: Diagrammatic representation of the respondents according to their annual income(X_7)

Table 6.7 and Fig. 6.7 present the distribution of respondents according to their annual income. Among the total respondents, majority belonging to the group of Rs 1,15000/-2,87000/ that means medium annual income (63.50%), followed by greater than Rs 2,87000 annual income that means high annual income (19.50%) and less than Rs1,15000/ that means low annual income (17.00%) category. The distribution of respondents is ranging from Rs 70,000/-5, 20000/ annual income with a mean of Rs 2, 01000/ annual income and a standard deviation of 0.86. The coefficient of variation of total distribution is 42.78% which implies a very medium level of consistency. Annual income always depicts economic status of the family. Sometimes it also

reflects the exposure through which a farmer can develop his perceptual insights on a particular subject. It is expected that medium level family annual income can influence the farmers to develop their perceptual ability for depicting the extremities of disaster resilience in agriculture.

6.1.2.4 Annual expenditure

Table 6.8: Distribution of the respondents according to their Annual expenditure(X_8) n=200

Category	Annual expenditure (Rs in Lac)	Frequency	Percentage	Statistics
Low	<1.07	41	20.50	Range=0.60-4
Medium	1.07 - 2.47	126	63.0	Mean=1.76
High	>2.45	33	16.5	SD=0.69
				CV=39.14%

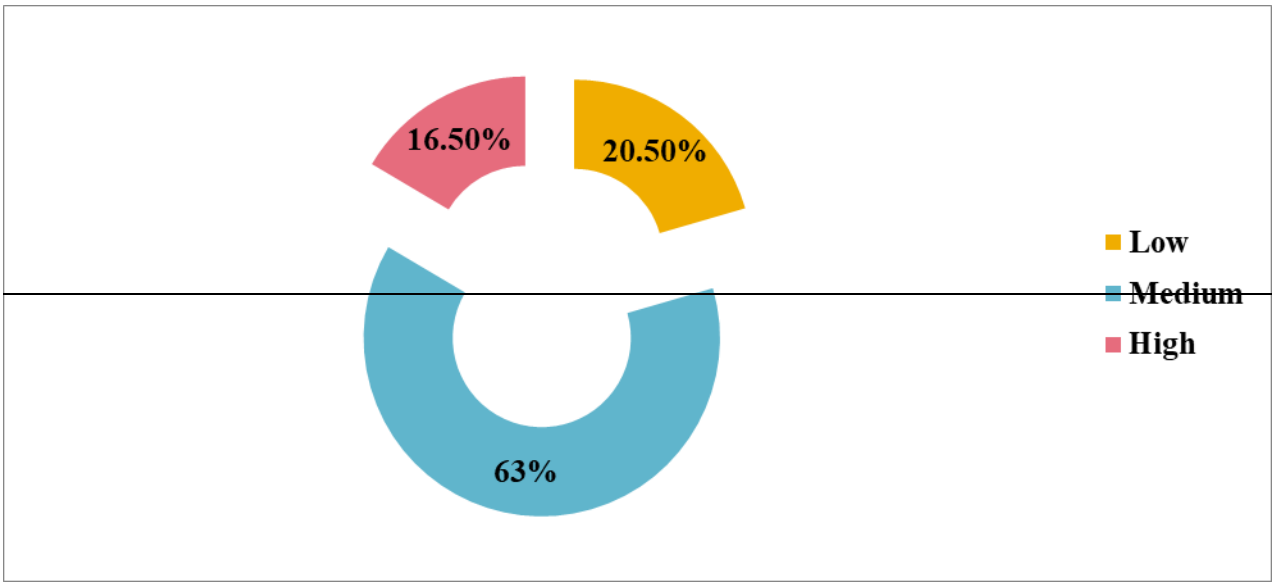


Fig.6.8: Diagrammatic representation of the respondents according to their Annual expenditure (X_8)

Table 6.8 and Fig. 6.8 present the distribution of respondents according to their annual expenditure. Among the total respondents, majority belonging to the group of Rs 1,07,000/-2,47,000/ that means medium annual expenditure (63.00%), followed by less than Rs 1,07,000/ annual expenditure that means low annual expenditure (20.50%) and higher than Rs 2,47,000/ that means high annual expenditure (16.50%) category. The distribution of respondents is ranging from Rs 60,000/-4, 00000/ annual expenditure with a mean value of Rs 1,76,000/ and a

standard deviation of 0.69. The coefficient of variation of total distribution is 39.14% which implies a very medium level of consistency. There exist similarities between the income and expenditure patterns of the farmer, as is depicted by tables 6.7 and 6.8. It is logical to say that lower incomes would invite lower expenditure levels. The variable annual expenditure implies the progressive well-beingness of the family. It is expected that medium level family annual expenditure can influence the farmers to develop their exact perceptual ability for depicting the extremities of disaster resilience in agriculture.

6.1.3 Extension and Communication attributes

6.1.3.1 Social participation

Table 6.9: Distribution of the respondents according to their social participation (X_9) n=200

Category	Social participation	Frequency	Percentage	Statistics
Low	<1	0	0	Range=1-6
Medium	1 - 3	188	94	Mean=1.80
High	>3	12	6	SD=0.98
				CV=0.54%

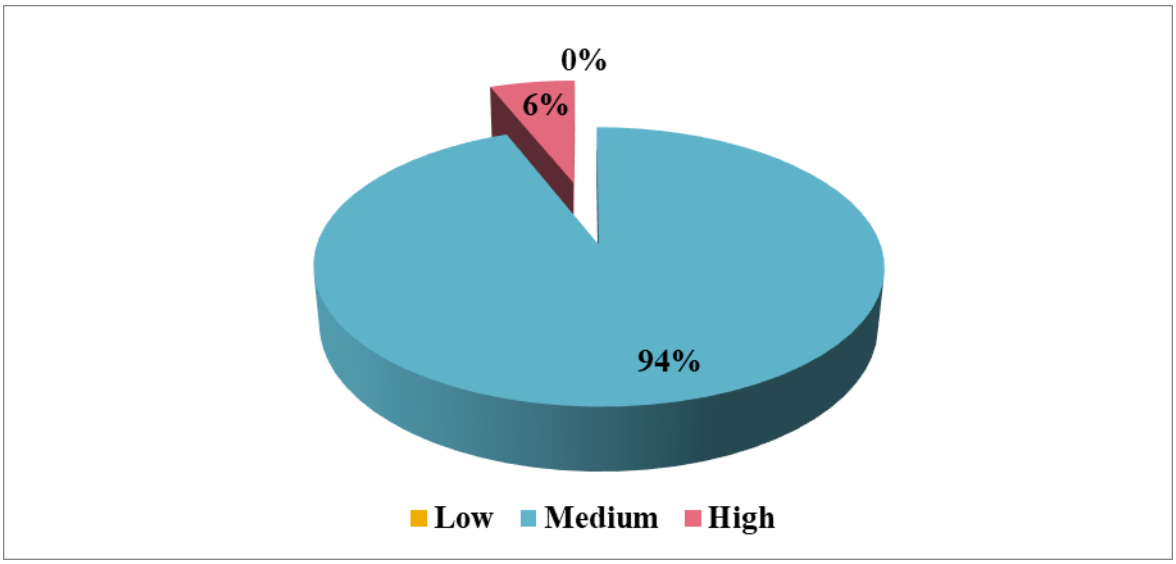


Fig.6.9: Diagrammatic representation of the respondents according to their social participation (X_9)

Table 6.9 and Fig. 6.9 present the distribution of respondents according to social participation. Among the total respondents, overwhelming majority belonging to the group of 1-3 membership that means medium level social participation (94%), followed by a group of more than 3 membership that means high level of social participation (6%) and no respondent belongs to low

level of social participation category. The distribution of respondents is ranging from 1 – 6 with a mean social participation of 1.80 and a standard deviation of 0.98. The coefficient of variation of total distribution is 54.00 % which implies a medium level of consistency. Social participation empowers the farming community to develop their insights through experiences and exposure. In the present study medium level social participation may develop the concept for explaining the perception of farmers on depicting the extremities of farm disaster resilience.

6.1.3.2 Extension contact

Table 6.10(a): Distribution of the respondents according to their Extension contact (X_{10}) n=200

Category	Extension contact	Frequency	Percentage	Statistics
Low	<1.00	17	8.5	Range=0-5
Medium	1 - 3	161	80.5	Mean=1.82
High	>3.00	22	11	SD=1.15
				CV=63.18%

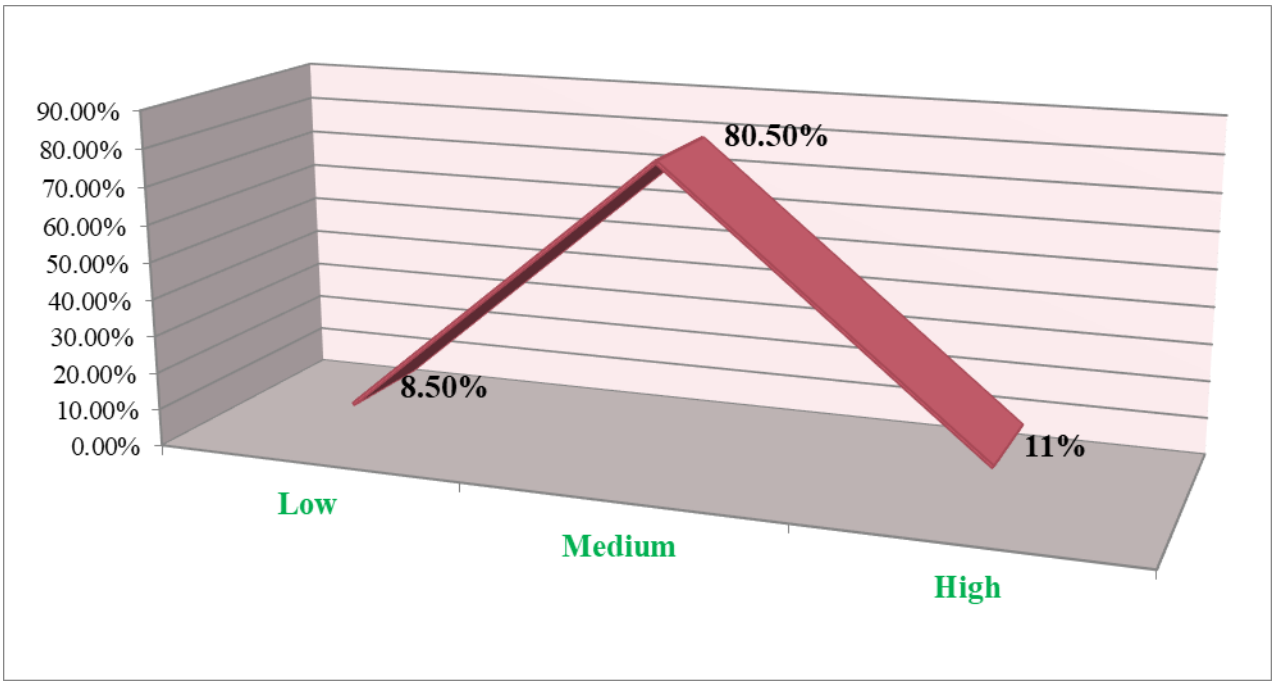


Fig. 6.10: Diagrammatic representation of the respondents according to their Extension contact (X_{10})

Table 6.10(a) and Fig 6.10 present the distribution of respondents according to extension contact. Among the total respondents, vast majority belonging to the group of score 1-3 that means

medium level extension contact (80.50%), followed by a group of more than 3 scores that means high level of extension contact (6%) and less than 1 means to low level extension contact category. The distribution of respondents is ranging from 0 – 5 with a mean value of 1.82 and a standard deviation of 1.15. The coefficient of variation of total distribution is 63.18% which implies a low level of consistency. Contact and inward/outward communication is very important to access new skill on innovation by the farmer from different extension delivery system. Extension contact empowers the farming community to develop their insights through contact and exposure. In the present study medium level extension contact may develop the concept for explaining the perception of farmers on depicting the extremities of farm disaster resilience.

Table 6.10(b): Distribution of the respondents according to their frequency of Extension contact (X_{10}) n=200

Category	Frequency of contact			Mean Score
	Regularly	Sometimes	Never	
VLEW/AEA	54(27)	121(60.5)	25(12.5)	76.33
ADO	3(1.5)	26(13)	169(64.5)	10.66
Ag. Scientist/KVK personnel	42(21)	78(39)	80(40)	54.00
NGO personnel	0(0)	38(19)	162(81)	12.66

**Figures within parentheses indicate percentage

The distribution of respondents according to frequency of contact with different sources is presented in Table 6.10(b). It is evident from the Table that majority of the respondents (27.00%) have regular contact with VLEW/ AEA followed by 21.00 per cent of the respondents having regular contact with Ag Scientist/KVK personnel. Only three respondents (1.50%) have regular contact with ADO while none of the respondents have regular contact with NGO personnel. Majority of the respondents (60.50%) have contact with VLEW/ AEA sometimes, followed by 39.00 per cent of the respondents who contacted with Ag. Scientist/KVK personnel sometimes and then 19.00 per cent have contact with NGO personnel sometimes. Only 13.00 per cent of them having contact with ADO sometimes. Majority of the respondents (81.00%) have never contact with NGO personnel, followed by 64.50 per cent of the respondents who have never contact with NGO personnel and 40.00 per cent have never contact with Ag. Scientist/KVK personnel. A small proportion of them (12.50%) have never contact with VLEW/ AEA. It is found that VLEW/ AEA has highest mean score (76.33) of frequency of contact.

6.1.3.3 Mass media exposure

Table 6.11(a): Distribution of the respondents according to their Mass media exposure (X_{11}) n=200

Category	Mass media exposure	Frequency	Percentage	Statistics
Low	<6.00	45	22.5	Range=4-13
Medium	6 -11	118	59	Mean=8.57
High	>11.00	37	18.5	SD=2.82
				CV=32%

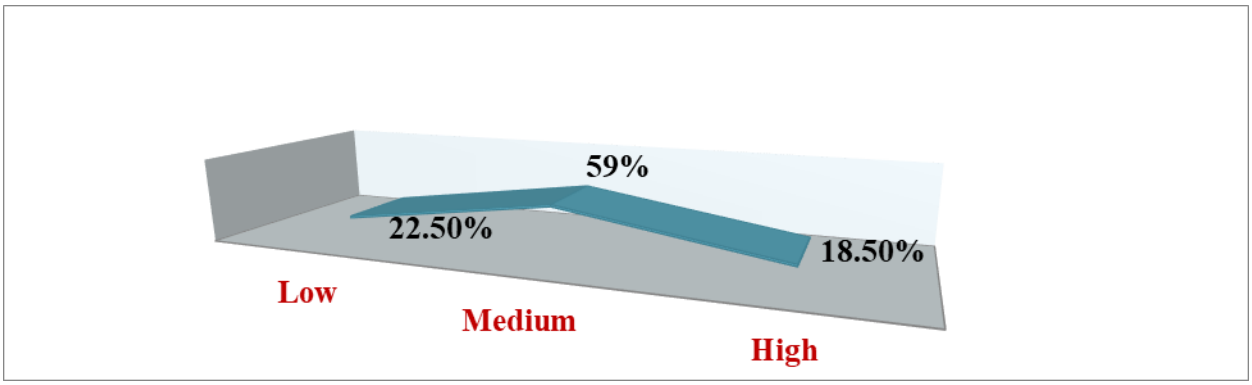


Fig.6.11: Diagrammatic representation of the respondents according to their Mass media exposure (X_{11})

Table 6.11(a) and Fig. 6.11 present the distribution of respondents according to mass media exposure. Among the total respondents, over half majority belonging to the group of score 6-11 that means medium level of mass media exposure (59%), followed by a group of less than score 6 that means low level of mass media exposure (22.5%) and more than score 11 means to high level mass media exposure category. The distribution of respondents is ranging from 4–13 with a mean value of 8.57 and a standard deviation of 2.82. The coefficient of variation of total distribution is 32.00% which implies a moderate level of consistency. Mass media plays pivotal role to aware the farmer about the new agricultural technologies available in agricultural universities and research institute to be utilized in local situation for bio-physical resource endowment and economic empowerment. In the present study medium level mass media exposure may develop the concept for explaining the perception of farmers on depicting the extremities of farm disaster resilience.

Table 6.11(b): Distribution of the respondents according to their frequency of Mass media exposure (X_{11}) n=200

Category	Frequency of Use			Mean Score
	Regularly	Sometimes	Never	
Newspaper	18(9)	83(41.5)	99(49.5)	39.66
Television	39(19.5)	128(64)	33(16.5)	68.66
Mobile Phones	32(16)	107(53.5)	61(30.5)	57.00
Farm Publication	6(3)	27(13.5)	167(83.5)	13.00
Exhibition	22(11)	100(50)	78(39)	48.00
Demonstration	11(5.5)	68(34)	121(60.5)	30.00

**Figures within parentheses indicate percentage

The distribution of respondents according to frequency of use of different mass media is presented in Table 6.11(b). It is evident that majority of the respondents (19.5%) regularly used television as the source of information, followed by 16 per cent uses mobile phones regularly as their source of information and 11 per cent regularly visit exhibition as their source of information. While 5.5 per cent visit demonstration regularly and 9.0 per cent use newspaper regularly as the source of information and only 3.0 per cent use farm publication as source of information. Majority of them (64%) use television sometimes followed by 53.50 per cent of the respondents who sometimes use mobile phones as their source of information. A sizeable 50.00 per cent and 41.50 percent of respondents sometimes visit demonstration and use newspaper as their information source. While 34.00 per cent of them sometimes visit demonstration and use farm publication for getting information. Majority of them (83.50%) never use farm publication followed by 60.50 per cent of the respondents who never visit demonstration as source of information. A sizeable 49.50 per cent and 39.00 per cent of them never use newspaper and visited exhibition for information. While 30.50 per cent and 16.5 per cent of them never use mobile phone and television for getting the information. It is found that Television has highest mean score (76.33) of frequency of use with respect to mass media exposure.

6.1.3.4 Training exposure

Table 6.12: Distribution of the respondents according to their Training exposure (X_{12}) n=200

Category	Training exposure	Frequency	Percentage	Statistics
Low	<1	18	9	Range=0-16
Medium	1 - 9	170	88	Mean=4.88
High	>9	26	13	SD=3.72
				CV=76.29%

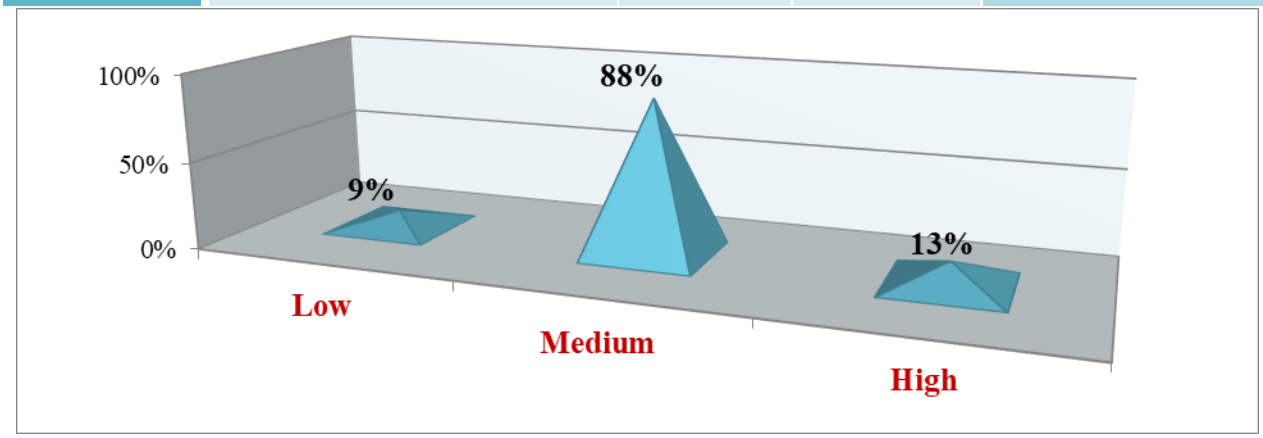


Fig.6.12: Diagrammatic representation of the respondents according to their Training exposure (X_{12})

Table 6.12 and Fig. 6.12 present the distribution of respondents according to training exposure**.** Among the total respondents, vast majority belongs to the group of score 1-9 which represents medium level of training exposure (88.00%), followed by greater than score 9 which represents high training exposure (13%) and less than score 1 that means to low level training exposure (9%) category. The distribution of respondents is ranging from 0–16 with a mean value of 4.88 and a standard deviation of 3.72. The coefficient of variation of total distribution is 76.29% which implies a low level of consistency. Training makes individual perfect to utilize the skill in local situation. It empowers the farming community to make them able for application of adopted technologies for agricultural and economic development. In the present study, it is expected that medium level of training exposure may explain the perception of farmers in the case of depicting the extremities of farm disaster resilience.

6.1.4 Socio-psychological attributes

6.1.4.1 Innovativeness

Table 6.13: Distribution of the respondents according to their Innovativeness (X_{13}) n=200

Category	Innovativeness	Frequency	Percentage	Statistics
Low	<2	3	1.5	Range=1-14
Medium	2 - 9	174	87	Mean=5.45
High	>9	23	11.5	SD=3.15
				CV=57.87%

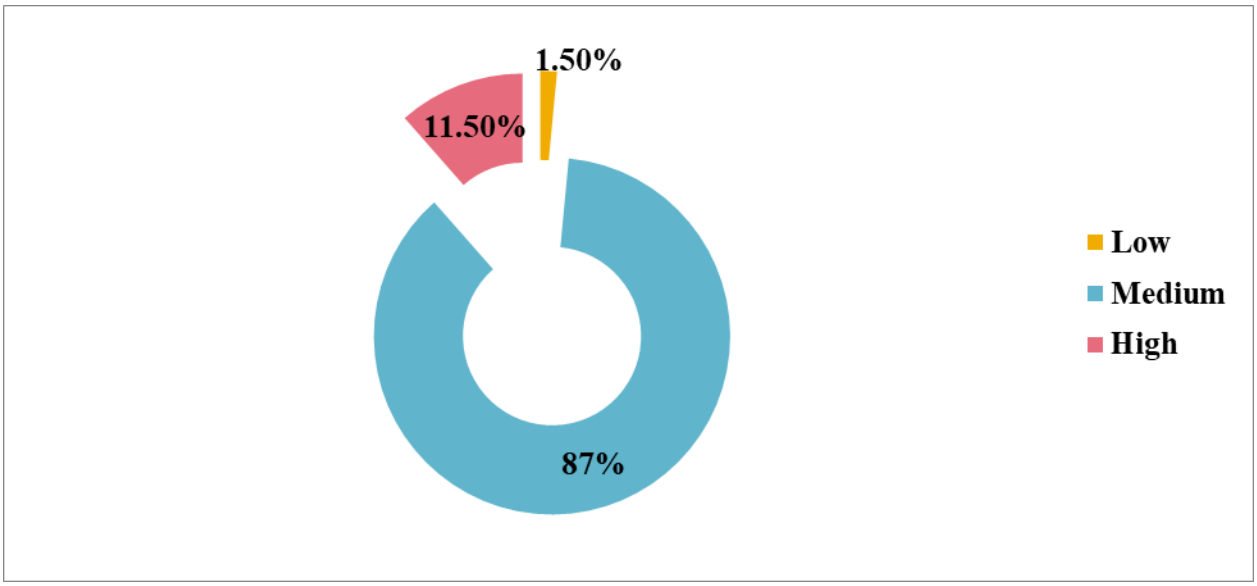


Fig.6.13: Diagrammatic representation of the respondents according to their Innovativeness (X_{13})

Table 6.13 and Fig. 6.13 present the distribution of respondents according to innovativeness. Among the total respondents, vast majority belongs to the group of score 2-9 which represents medium level innovativeness (87.00%), followed by greater than score 9 which represents high level innovativeness (11.5%) and less than score 2 that means to low level innovativeness (1.5%) category. The distribution of respondents is ranging from 1–14 with a mean value of 5.45 and a standard deviation of 3.15. The coefficient of variation of total distribution is 57.87% which implies a low level of consistency. The farmers can be acknowledged through his/her innovativeness in case of developing perceptual ability to cope with the challenges associated with the agriculture. In the present study, it is expected that medium level of innovativeness may

explain the perception of farmers in the case of depicting the extremities of farm disaster resilience.

6.1.4.2 Economic motivation

Table 6.14: Distribution of the respondents according to their Economic motivation(X_{14}) n=200

Category	Economic motivation	Frequency	Percentage	Statistics
Low	<23.00	0	0	Range=21-34
Medium	23 - 31	167	83.5	Mean=27.00
High	>31.00	33	16.5	SD=4.00
				CV=14.81%

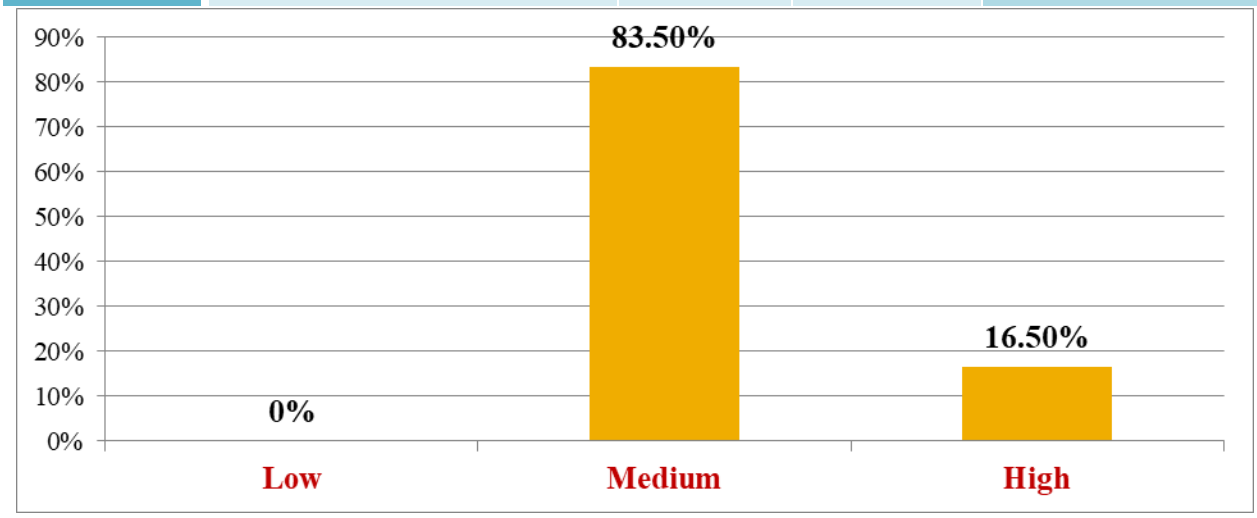


Fig.6.14: Diagrammatic representation of the respondents according to their Economic motivation(X_{14})

Table 6.14 and Fig. 6.14 present the distribution of respondents according to economic motivation. Among the total respondents, majority belongs to the score 23-31 which represents medium level economic motivation (83.50%), followed by greater than score 31 which represents high level economic motivation (16.5%) and no respondent belong to low level economic motivation (0.00%) category. The distribution of respondents is ranging from 21–34 with a mean value of 27 and a standard deviation of 4.00. The coefficient of variation of total distribution is 14.81% which implies a high level of consistency. Economic motivation reflects the intrinsic driving force of an individual towards achieving economic affiliation. In the present study, it is expected that medium level of economic motivation may explain the perception of farmers in the case of depicting the extremities of farm disaster resilience.

6.1.4.3 Scientific orientation

Table 6.15: Distribution of the respondents according to their Scientific orientation(X_{15}) n=200

Category	Scientific orientation	Frequency	Percentage	Statistics
Low	<23.00	38	19	Range=20-36
Medium	23 - 33	110	55	Mean=28.00
High	>33.00	52	26	SD=5.00
				CV=17.85%

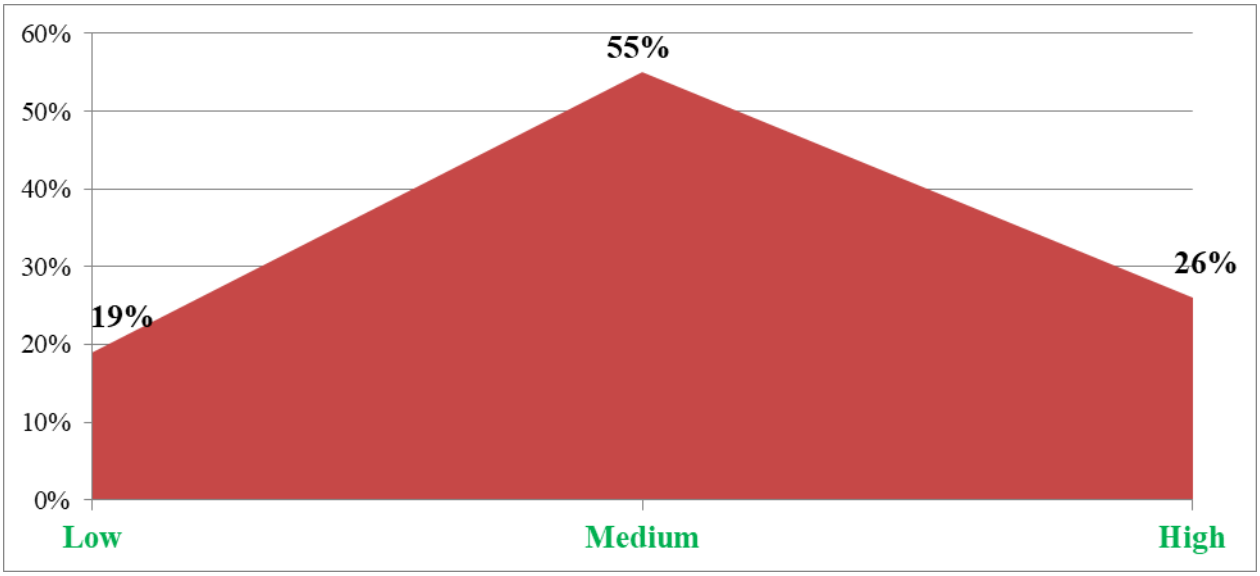


Fig.6.15: Diagrammatic representation of the respondents according to their Scientific orientation(X_{15})

Table 6.15 and Fig. 6.15 show the distribution of respondents according to scientific orientation. Among the total respondents, over half majority belongs to the score 23-33 which represents medium level scientific orientation (55.50%), followed by greater than score 33 which represents high level scientific orientation (26%) and less than score 23 which means low level of scientific orientation. The distribution of respondents is ranging from 20–36 with a mean value of 28 and a standard deviation of 5.00. The coefficient of variation of total distribution is 17.85% which implies a high level of consistency. Scientific orientation reflects the logic behind the adoption of any technology by the farmers. In the present study, it is expected that medium level of scientific orientation may explain the perception of farmers in the case of depicting the extremities of farm disaster resilience.

6.1.4.4 Management orientation

Table 6.16: Distribution of the respondents according to their Management orientation(X_{16}) n=200

Category	Management orientation	Frequency	Percentage	Statistics
Low	<38.00	17	8.5	Range=36-56
Medium	38 - 52	142	71	Mean=45.00
High	>52.00	41	20.5	SD=7.00
				CV=15.56%

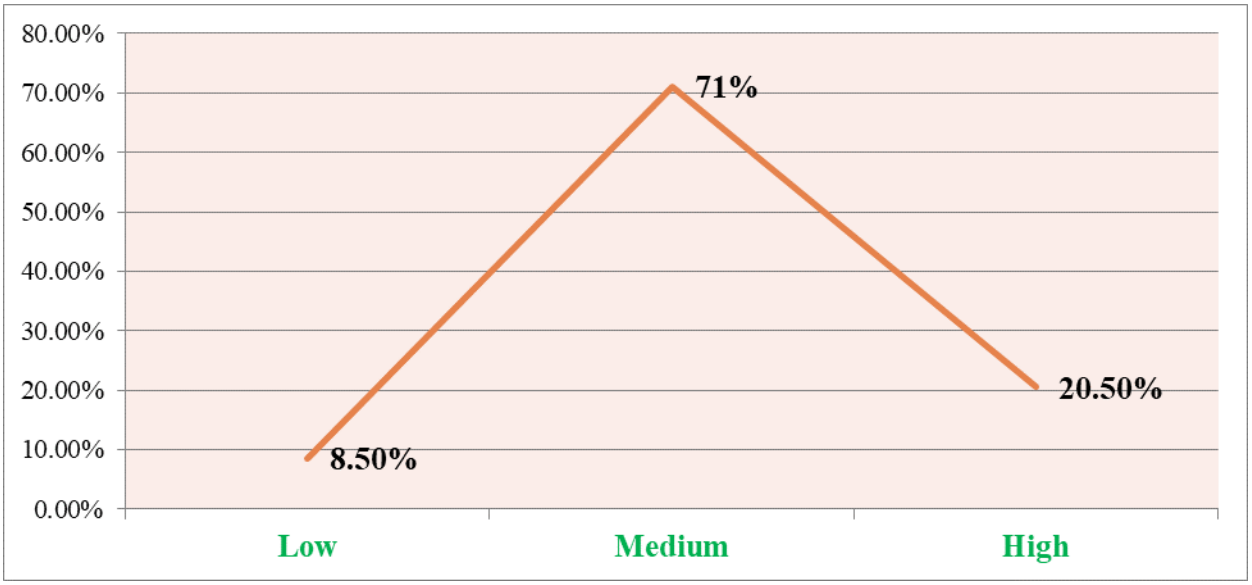


Fig.6.16: Diagrammatic representation of the respondents according to their Management orientation (X_{16})

Table 6.16 and Fig. 6.16 present the distribution of respondents according to management orientation. Among the total respondents, majority belongs to the score 38-52 which represents medium level management orientation (71.00%), followed by greater than score 52 which represents high level management orientation (20.5%) and less than score 38 which means low level of management orientation. The distribution of respondents is ranging from 36-56 score with a mean value of 45 and a standard deviation of 7.00. The coefficient of variation of total distribution is 15.56% which implies a high level of consistency. The management orientation helps in developing the managerial capability of an individual in applying agricultural innovation. In the present study, it is expected that medium level of management orientation may

explain the perception of farmers in the case of depicting the extremities of farm disaster resilience.

6.1.4.5 Risk bearing ability

Table 6.17: Distribution of the respondents according to their Risk bearing ability(X_{17}) n=200

Category	Risk bearing ability	Frequency	Percentage	Statistics
Low	<21.00	33	16.5	Range=18-28
Medium	21 - 25	146	73	Mean=23.00
High	>25.00	21	10.5	SD=2.00
				CV=8.69%

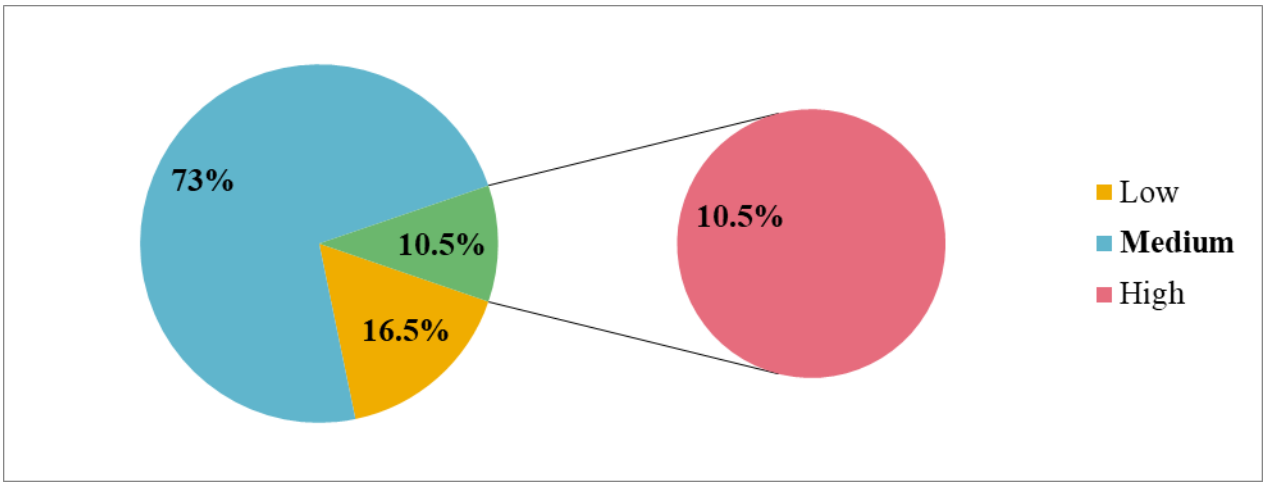


Fig. 6.17: Diagrammatic representation of the respondents according to their Risk bearing ability (X_{17})

Table 6.17 and Fig. 6.17 show the distribution of respondents according to risk bearing ability. Among the total respondents, the majority belongs to the score 21-25 which represents medium level risk bearing ability (73.0%), followed by less than score 21 which represents low level risk bearing ability (16.5%) and higher than score 25 which means high level of risk bearing ability. The distribution of respondents is ranging from 18–28 with a mean value of 23 and a standard deviation of 2.00. The coefficient of variation of total distribution is 8.69% which implies a very high level of consistency. Risk bearing ability implies ability to accept the risk and challenges embedded with the agricultural innovation system. Risk bearing ability logically increases when farmers have good income levels and have more productive and disaster-free land resources. On both these aspects the respondents are weak and hence they do not have high risk bearing ability.

In the present study, it is expected that medium level of risk bearing ability may explain the perception of farmers in the case of depicting the extremities of farm disaster resilience.

6.1.4.6 Emotional intelligence

Table 6.18: Distribution of the respondents according to their Emotional intelligence(X_{18}) n=200

Category	Emotional intelligence	Frequency	Percentage	Statistics
Low	<80	44	22	Range=72-142
Medium	80 - 118	111	55.5	Mean=99.08
High	>118	45	22.5	SD=19.30
				CV=19.48%

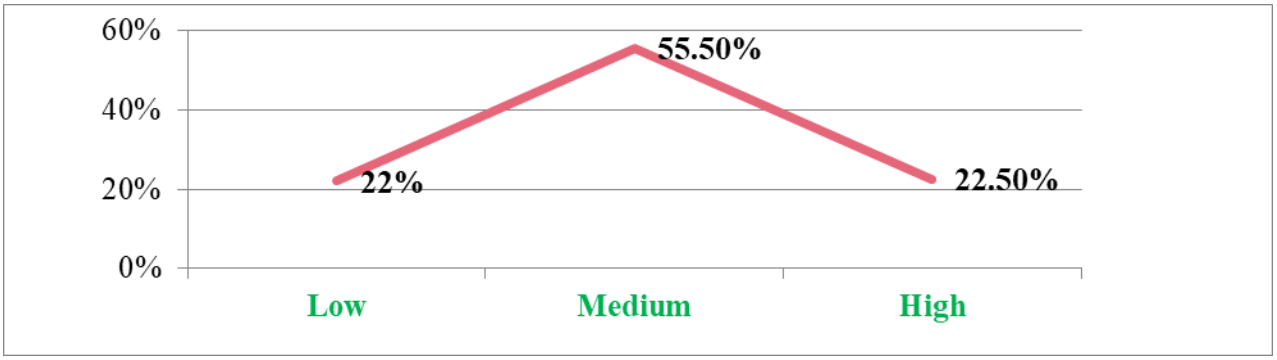


Fig.6.18: Diagrammatic representation of the respondents according to their Emotional intelligence (X_{18})

Table 6.18 and Fig. 6.18 show the distribution of respondents according to emotional intelligence. Among the total respondents, majority belongs to the score 80-118 which represents medium emotional intelligence (55.50%), followed by higher than score 118 which represents high risk bearing ability (22.5%) and less than score 80 which means low level of risk bearing ability. The distribution of respondents is ranging from 72-142 with a mean value of 99.08 and a standard deviation of 19.30. The coefficient of variation of total distribution is 19.48% which implies a high level of consistency. Emotional intelligence reflects ability to learn various practical skills that are based on five components: self-awareness, self-motivation, self-control of emotions, empathy and harmonization mastery of human relationships. In the present study, it is expected that medium level of emotional intelligence may explain the perception of farmers in the case of depicting the extremities of farm disaster resilience.

6.2 Computation of Farmers' Disaster Resilience

Farmers' Disaster Resilience is computed with Farmer Resilience Index that has four dimensions namely economic resilience index, social resilience index, technical resilience index, and physical resilience index

6.2.1 Economic resilience index

Table 6.19: Distribution of the respondents according to their Economic resilience index (Y_1)

Category	Economic Resilience index	Frequency	Percentage	Statistics
Low	<0.43	52	26	Range=0.3-0.6 Mean=0.50 SD=0.07 CV=14%
Medium	0.43 - 0.57	122	61	
High	>0.57	26	13	

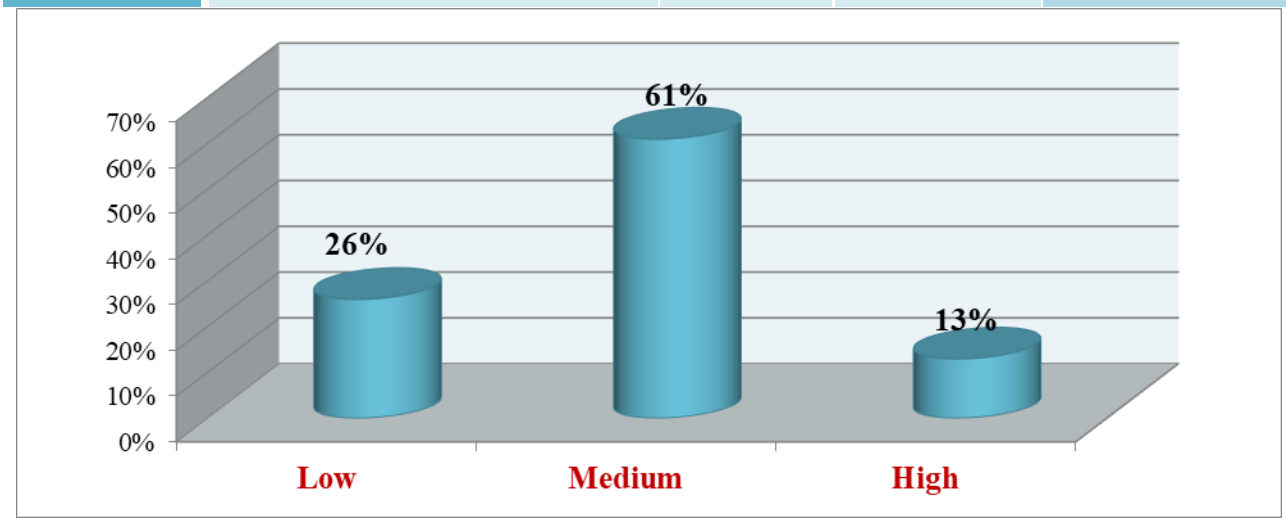


Fig.6.19: Diagrammatic representation of the respondents according to their Economic resilience index (Y_1)

Table 6.19 shows and Fig 6.19 depicts the distribution of respondents according to economic resilience index. Among the total respondents, majority belongs to the score 0.43 - 0.57 which represents medium level economic resilience index (61.0%), followed by less than score 0.43 which represents low level economic resilience index (26.0%) and higher than score 0.57 which means high level of economic resilience index (13%). The distribution of respondents is ranging from 0.3-0.6 with a mean value of 0.50 and a standard deviation of 0.07. The coefficient of variation of total distribution is 14% which implies a very high level of consistency. Economic resilience index reflects status of the diversity of household income source, off season income,

accessing the credit from different financial institute, crop insurance, household assets, farm assets etc. In the present study, it is expected that medium level of economic resilience index may explain the perception of farmers in the case of depicting the extremities of farm disaster resilience.

Table 6.20: Distribution of the Mean Weightage Score according to the indicators of Economic resilience index (Y_1)

Sl. No.	Economic Indicators	Mean Weightage Score
1	Diversity of Income source	0.649
2	Off-season Income	0.546
3	Recovery of income owing to a recent flood/drought/storm disaster	0.715
4	Receiving financial help from family members and relatives	0.316
5	Access to credit facility for farming activities	0.297
6	Access to credit facility to prevent disaster	0.267
7	Household saving practice	0.455
8	Crop insurance Accessibility	0.346
9	Availability of subsidies for field drainage infrastructure	0.343
10	Availability of subsidies for flood/drought-resistant agri inputs (seeds ,fertilizers etc)	0.380
11	Availability of subsidies/ incentives for farmers to reclaim flood/drought-affected lands	0.313
12	Cultivating Rabi crops after Kharif crops	0.662
13	Access to seed bank	0.322
14	Access to cold storage facilities	0.285
15	Availability of proper storage facilities	0.719
16	Availability of Radio	0.323
17	Availability of TV	0.791
18	Availability of Computer with internet	0.297
19	Availability of Mobile phones with Internet	0.606
20	Availability of Mobile phones without Internet	0.851
21	Availability of Motorized vehicle	0.576
22	Availability of water pump	0.509
23	Availability of farm tractor/power tiller	0.580
24	Availability of improved farm tools and implements	0.584
25	Application of agricultural technology in your farm	0.651
26	Availability of Business partnership with others	0.294
27	Ability to sale your farm produce(Bargaining power)	0.592

Table 6.20 depicts the distribution of mean weightage score according to the indicators of Economic resilience index (Y_1). It is observable from the table that mean weightage score are

very lower side regarding access to credit facility for farming activities and preventing disaster, access to cold storage facilities, availability of computer with internet, availability of business partnership with others. The table also indicates that mean weightage score are comparatively lower side in cases of crop insurance accessibility, availability of subsidies for field drainage infrastructure, flood/drought-resistant agri inputs (seeds, fertilizers, vermicompost etc), incentives for farmers to reclaim flood/drought-affected lands and access to seed bank. It can be understood that economic indicators having lower level of mean weightage score should get proper importance in policy and decision-making process for increasing farmers' economic resilience index.

6.2.2 Social resilience index

Table 6.21: Distribution of the respondents according to their Social resilience index (Y_2)

Category	Social Resilience index	Frequency	Percentage	Statistics
Low	<0.47	47	23.5	Range=0.4-0.6 Mean=0.53 SD=0.06 CV=11.32%
Medium	0.47 - 0.59	101	50.5	
High	>0.59	52	26	

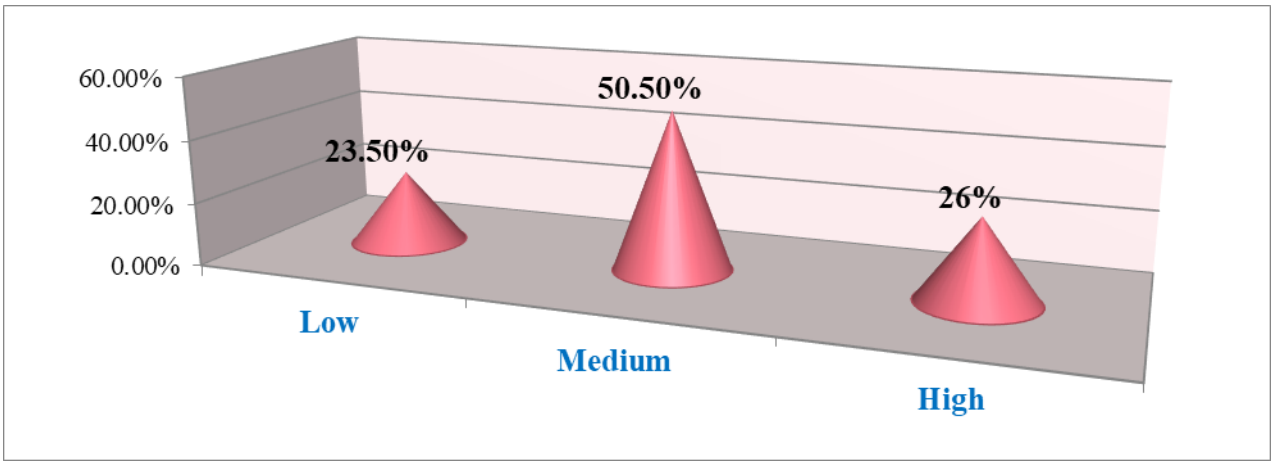


Fig.6.20: Diagrammatic representation of the respondents according to their Social resilience index (Y_2)

Table 6.21 presents and Fig 6.20 depicts the distribution of respondents according to social resilience index. Among the total respondents, about half majority belongs to the score 0.47 - 0.59 which represents medium level social resilience index (50.50%), followed by higher than score 0.59 which represents high level social resilience index (26.0%) and less than score 0.47

which means low level of economic resilience index (23.5%). The distribution of respondents is ranging from 0.4-0.6 with a mean value of 0.53 and a standard deviation of 0.06. The coefficient of variation of total distribution is 11.32% which implies a very high level of consistency. Social resilience index reflects the status of the household contribution to farm labour, activeness in any farmer-based organization, availability of public awareness programmes on flood/drought/storm etc disaster, access to extension and advisory service, access to basic service, availability of social safety net etc. In the present study, it is expected that medium level of social resilience index may explain the perception of farmers in the case of depicting the extremities of farm disaster resilience.

Table 6.22: Distribution of the Mean Weightage Score according to the indicators of Social resilience index (Y_2)

Sl. No.	Social Indicators	Mean Weightage Score
1	Household contribution to farm labour during and post disaster period	0.775
2	Contribution of extended family members/relatives towards farm labour during and post disaster period	0.571
3	Activeness in any Farmer based organization(FPO,FIG,CIG,SHG etc)	0.447
4	Awareness level about climate change	0.404
5	Availability of public awareness programmes on flood/drought/storm etc	0.315
6	Access to internet/social media	0.532
7	Access to Extension and Advisory Service (climate, farm disaster management training etc.)	0.302
8	Access to Basic Service (Health care)	0.313
9	Access to Basic Service (Drinking water)	0.751
10	Access to Basic Service (Shelter/safe house,)	0.554
11	Access to Basic Services (Electricity)	0.593
12	Access to Basic Services (Transport)	0.565
13	Availability of Social safety Net(Assistance in cash/ kind,)	0.564
14	Availability of Social safety Net(Job assistance/MGNREGA)	0.649
15	Availability of Social safety Net(PDS)	0.659
16	Availability of Social safety Net(Old Age pension Scheme)	0.491
17	Availability of Relief material	0.663
18	Availability of Social safety Net(IAY/PMAY)	0.474

Table 6.22 shows the distribution of mean weightage score according to the indicators of Social resilience index (Y_2).It is observable from the table that mean weightage score are lower side pertaining to availability of public awareness programmes on flood/drought/storm etc, access to extension and advisory service (climate, farm disaster management training etc.), awareness level about climate change, activeness in any farmer based organization(FPO,FIG,CIG,SHG etc, availability of social safety net PMAY, and old age pension scheme. The table also states that mean weightage score are comparatively lower side in cases of access to internet/social media, access to basic service such as shelter/safe house, electricity, transport and availability of social safety net (assistance in cash/ kind). It can be stated that social indicators having lower level of mean weightage score should get due importance for increasing farmers' social resilience index.

6.2.3 Technical resilience index

Table 6.23: Distribution of the respondents according to their Technical resilience index (Y_3)

Category	Technical Resilience Index	Frequency	Percentage	Statistics
Low	<0.51	31	15.5	Range=0.4-0.7 Mean=0.57 SD=0.06 CV=10%
Medium	0.51 - 0.63	129	64.5	
High	>0.63	40	20	

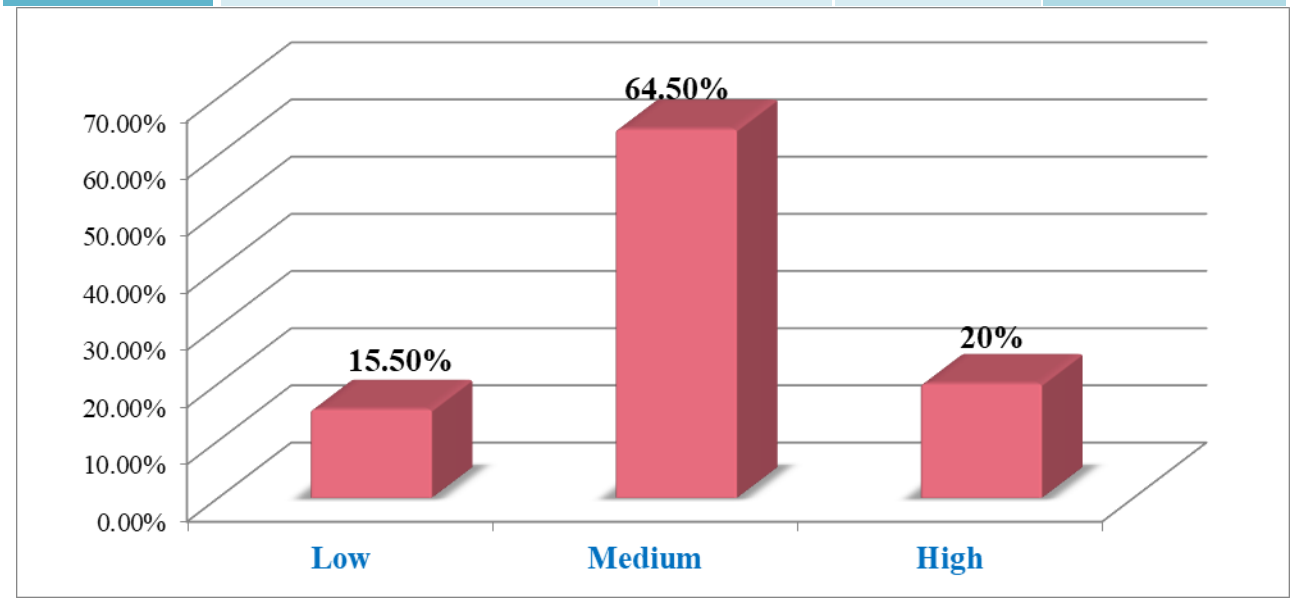


Fig.6.21: Diagrammatic representation of the respondents according to their Technical resilience index (Y_3)

Table 6.23 presents and Fig 6.21 depicts the distribution of respondents according to technical resilience index. Among the total respondents, majority belongs to the score 0.51 - 0.63 which represents medium level technical resilience index (64.50%), followed by higher than score 0.63 which represents high level technical resilience index (20.0%) and less than score 0.51 which means low level of technical resilience index (15.5%). The distribution of respondents is ranging from 0.4-0.7 with a mean value of 0.57 and a standard deviation of 0.06. The coefficient of variation of total distribution is 10.0% which implies a very high level of consistency. Technical resilience index reflects the status of the household contribution to farm labour, activeness in any farmer based organization , availability of public awareness programmes on flood/drought/storm etc disaster , access to extension and advisory service, access to basic service, availability of social safety net etc. In the present study, it is expected that medium level of technical resilience index may explain the perception of farmers in the case of depicting the extremities of farm disaster resilience.

Table 6.24: Distribution of the Mean Weightage Score according to the indicators of Technical resilience index (Y_3)

Sl. No.	Technical Indicators	Mean Weightage Score
1	Knowledge of flood resistant Varieties	0.798
2	Knowledge of drought resistant Varieties	0.625
3	Knowledge of early maturing varieties	0.741
4	Knowledge of intercropping	0.781
5	Knowledge of relay Cropping	0.826
6	Knowledge of integrated nutrient management	0.559
7	Knowledge of crop rotation	0.769
8	Knowledge of multiple cropping	0.731
9	Knowledge of integrated farming System	0.794
10	Knowledge of unconventional production practices(poly house/green house cultivation etc)	0.518
11	Knowledge of unconventional production practices (Knowledge of changed planting/sowing dates)	0.568
12	Knowledge of modern plant protection technologies	0.558
13	Access to daily weather Data	0.678
14	Access to flood/drought/storm disaster Warnings	0.589
15	Access to weather predictions from reliable sources (GKMS/IMD etc.)	0.528
16	Knowledge of applications/websites developed for sharing climate/weather information	0.335

Table 6.24 shows the distribution of mean weightage score according to the indicators of Technical resilience index (Y_3). It is observable from the table that mean weightage scores are comparatively low regarding knowledge of weather/climate based applications/websites. knowledge of unconventional production practices (poly house/green house cultivation etc, and changed planting/sowing dates), access to flood/drought/storm disaster warnings and weather predictions from reliable sources (GKMS/IMD etc.). It can be stated that social indicators having lower level of mean weightage score should get due importance for increasing farmers' technical resilience index.

6.2.4 Physical resilience index

Table 6.25: Distribution of the respondents according to their Physical resilience index (Y_4)

Category	Physical Resilience Index	Frequency	Percentage	Statistics
Low	<0.36	16	8	Range=0.3-0.5 Mean=0.40 SD=0.04 CV=10%
Medium	0.36-0.44	152	76	
High	>0.44	32	16	

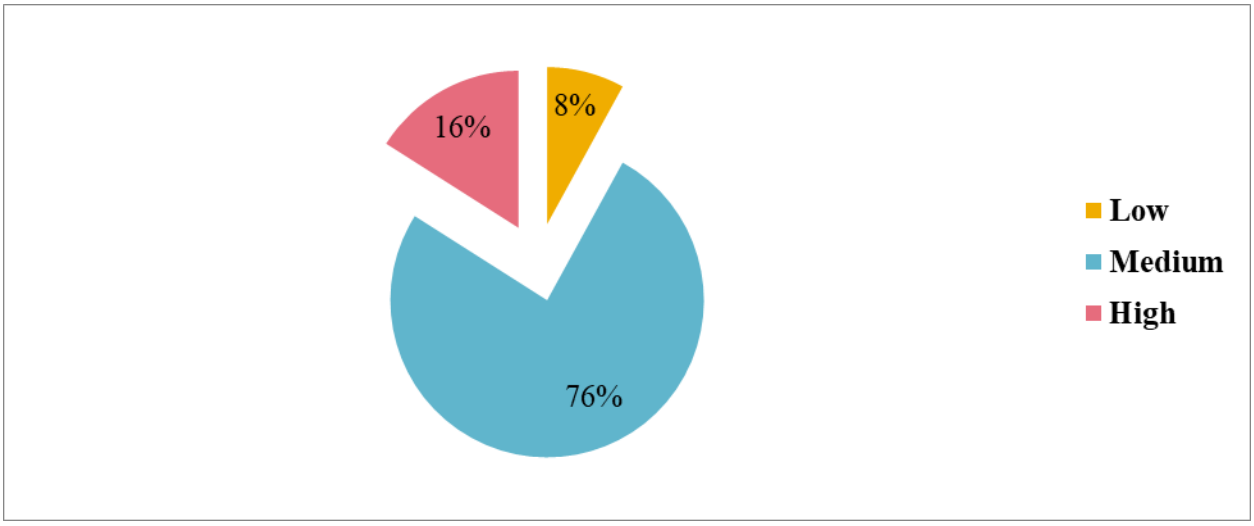


Fig.6.22: Diagrammatic representation of the respondents according to their Physical resilience index (Y_4)

Table 6.25 presents and Fig 6.22 shows the distribution of respondents according to physical resilience index. Among the total respondents, majority belongs to the score 0.36-0.44 which represents medium level physical resilience index (76.0%), followed by higher than score 0.44 which represents high level physical resilience index (16.0%) and less than score 0.36 which means low level of physical resilience index (8.0%). The distribution of respondents is ranging from 0.3-0.5 with a mean value of 0.40 and a standard deviation of 0.04. The coefficient of variation of total distribution is 10.0% which implies a very high level of consistency. Physical resilience index reflects the status of farm land; field drainage and irrigation infrastructure; access to good road and electricity etc. In the present study, it is expected that medium level of physical resilience index may explain the perception of farmers in the case of depicting the extremities of farm disaster resilience.

Table 6.26: Distribution of the Mean Weightage Score according to the indicators of physical resilience index (Y_4)

Sl. No.	Physical Indicators	Mean Weightage Score
1	Fully owned operational land holding	0.793
2	Long term tenure operational land holding	0.687
3	Availability of upland operational land holding(flood free)	0.278
4	Availability of irrigation facilities	0.456
5	Availability of proper drainage system in your farm land	0.250
6	Availability of Farm pond	0.467
7	Access of farm to the nearby main road	0.448
8	Access to farm roads from house during flood events	0.256
9	Availability of uninterrupted road after disaster events	0.276
10	Access to electricity for agriculture purpose	0.289
11	Availability of uninterrupted electricity	0.315

Table 6.26 shows the distribution of mean weightage score according to the indicators of physical resilience index (Y_4). It is observable from the table that mean weightage score are very low regarding availability of flood free operational landholding, proper drainage system, access to farm roads from house during flood events, availability of uninterrupted road after disaster events and access to electricity for agriculture purpose. Availability of irrigation facilities also caries comparatively low mean weightage score. It can be understood that social indicators having lower level of mean weightage score should get due importance for increasing farmers' physical resilience index.

6.2.5 Farmer resilience index

Table 6.27: Distribution of the respondents according to Farmer resilience index (Y_5)

Category	Farmer Resilience Index	Frequency	Percentage	Statistics
Low	<0.53	28	14	Range=0.49-0.63
Medium	0.53-0.57	107	53.5	Mean=0.55
High	>0.57	65	32.5	SD=0.02
				CV=3.63%

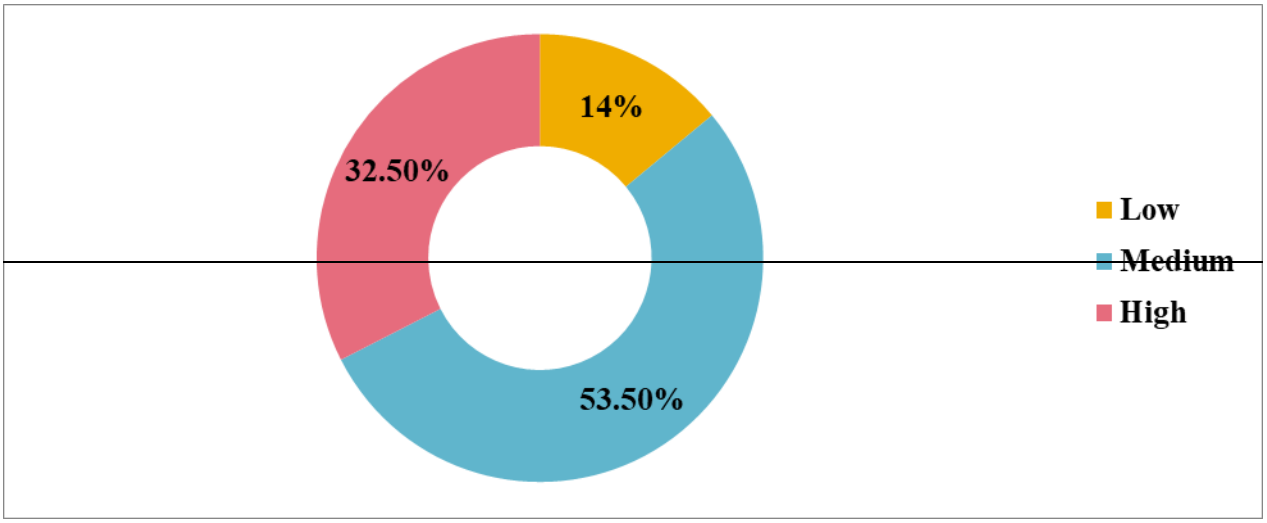


Fig.6.23: Diagrammatic representation of the respondents according to their Farmer resilience index (Y_5)

Table 6.27 presents and Fig 6.23 shows the distribution of respondents according to Farmer resilience index. Among the total respondents, over half majority belongs to the score 0.53-0.57 which represents medium level farmer resilience index (53.50.0%), followed by higher than score 0.53 which represents high level farmer resilience index (32.50%) and less than score 0.53 which means low level of farmer resilience index (14.0%). The distribution of respondents is ranging from 0.49-0.63 with a mean value of 0.55 and a standard deviation of 0.02. The coefficient of variation of total distribution is 3.63% which implies a very high level of consistency. Farmer resilience index reflects the status of the economic resilience index, social resilience index, technical resilience index, and physical resilience index. In the present study, it is expected that medium level of farmer resilience index may explain the perception of farmers in the case of depicting the extremities of farm disaster resilience.

6.3 Factors associated with the Farmer resilience index

6.3.1 Coefficient of correlation(r) between Economic resilience index (Y_1) and 18 causal variables

Table 6.28 reflects the Pearson's coefficient of correlation among the dependent variable i.e. economic resilience index and 18 causal variables. The result shows that the variables namely operational land holding(X_5), annual income(X_7), annual expenditure(X_8), social participation(X_9), extension contact(X_{10}), mass media exposure(X_{11}), training exposure(X_{12}), economic motivation(X_{14}), scientific orientation(X_{15}), management orientation(X_{16}), risk bearing ability(X_{17}), emotional intelligence(X_{18}), are positively and significantly associated with the dependent variable, economic resilience index(Y_1).

Table 6.28: Coefficient of correlation(r) between Economic resilience index (Y_1) and 18 causal variables

Sl. No.	Variable	Coefficient of correlation(r)
Independent Variable		
Socio-personal variable		
1.	Age (X_1)	-0.172*
2.	Family education status(X_2)	0.096
3.	Farming experience(X_3)	-0.167*
4.	Family size(X_4)	-0.195**
Socio-economic variable		
5.	Operational land holding(X_5)	0.423**
6.	Cropping intensity(X_6)	-0.335**
7.	Annual income(X_7)	0.472**
8.	Annual expenditure(X_8)	0.486**
Extension-communication variable		
9.	Social participation(X_9)	0.211**
10.	Extension contact(X_{10})	0.520**
11.	Mass media exposure(X_{11})	0.363**
12.	Training exposure(X_{12})	0.279**
Socio-psychological variable		
13.	Innovativeness(X_{13})	0.137
14.	Economic motivation(X_{14})	0.524**
15.	Scientific orientation(X_{15})	0.262**
16.	Management orientation(X_{16})	0.266**
17.	Risk bearing ability(X_{17})	0.357**
18.	Emotional intelligence(X_{18})	0.313**

** Significant at 1 % level, * Significant at 5% level

On the other hand, the variables viz., age **(**X_1), farming experience**(**X_3), family size**(**X_4) and cropping intensity**(**X_6) are negatively and significantly associated with the dependent variable, economic resilience index(Y_1).

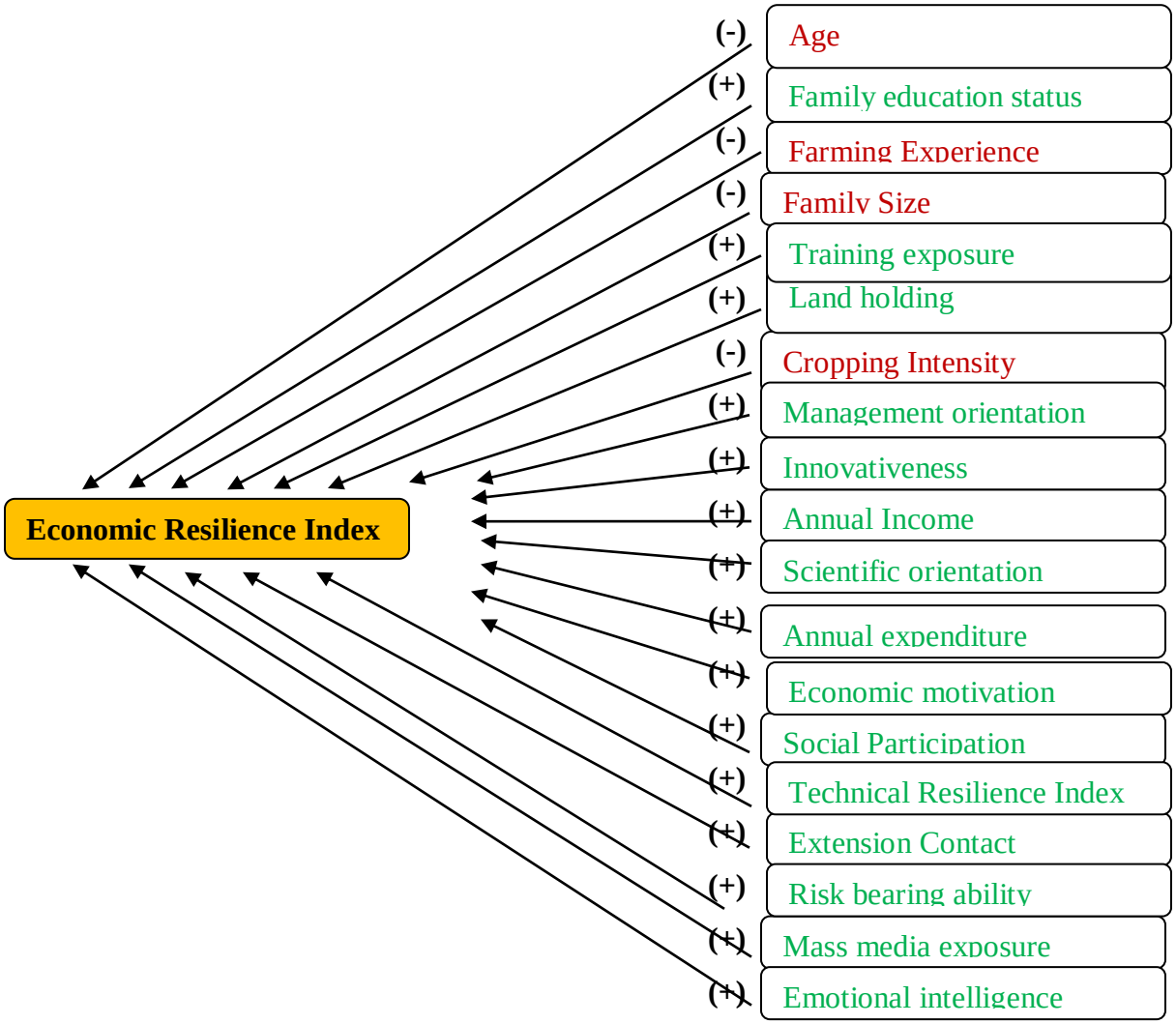


Fig.6.24: Diagrammatic representation of Coefficient of correlation(r) between Economic resilience index (Y_1) and 18 causal variables

Age and Economic resilience index

In the present study, the variable 'age' has been conceptualized as the chronological age of the farmer respondent. The age of the farmer is an essential factor in decision-making for the family. An increase in age of farmer with a less risk bearing capacity decreases economic resilience, as compared to the young aged farmers. Since the elderly farmers also can not actively engage in off-farm or off-season job activities for ensuring the economic stability of the household, an increase in age affects the economic resilience of the farmers. Young farmers are expected to embark actively on large scale food production and undertake jobs, alongside farming, which will increase the household food security or economic status and also cope the situation of various farm disasters. Consequently, the economic resilience of the household with old aged farmers is mostly affected than the household with young aged farmers. Therefore, the variable age is negatively and significantly associated with the dependent variable, Economic resilience index.

Farming experience and Economic resilience index

The farming experience of the respondents reflects the age-old experience about the production, protection and marketing practices of the agricultural produces. Logically, if age increases the traditional farming experiences also increases. More experienced farmers are not at all concerned about the agricultural credits, subsidies and crop insurance etc which can be adaptation strategies for enhancing farmers' resilience against various types of disasters. In contrary the less farming experienced farmers have the innovative approaches to agricultural finance, crop insurance, off season job, improved farm technologies etc. and learn and utilize the adaptation technologies in their local situation to increase resilience level by averting the risk of farm disaster. Consequently, the variable farming experience is negatively and significantly associated with the dependent variable, Economic resilience index.

Family size and Economic resilience index

The family size is representation of the total number of individuals present in a particular family. Sometimes the farmers economic resilience depends on the size of family because the large size family, the food and other resource requirement are always more compare to small family. Family size is a significant determinant of household food security and economic resilience against various natural disasters. A large family size puts an extra burden on food and other available resources consumption, and more likely to experience poor economic resilience in

contrast to households with a small family size. Members of large families tend to compete for the limited resources available in the household. As a strategy, large households tend to consume a limited volume of resources, without considering the quality of resource. Due to the farm disaster discourses the production of food is also limited in nature and the food system has a limited capacity to feed the large number of family members. That is why, the variable family size is negatively and significantly associated with the dependent variable, Economic resilience index.

Cropping intensity and Economic resilience index

Cropping intensity plays important role in enhancing the farmers, economic resilience. Logically increased gross crop area or cropping intensity tends to higher agricultural production leading to more income and economic resilience of farmers. It is observable that more the crop area irrespective of seasons make crop field susceptible to various natural disasters mainly flood, drought, frost, pest and diseases and hail storm etc. Farmers' cost of production for various agricultural inputs goes in vain and incurred heavy loss to agricultural production, once the farmers' field is struck with disasters. So, in such condition and farmers inability to access to agricultural finances and insurances push the farmer to a poor economic resilience against various farm disasters. Therefore, the variable cropping intensity is negatively and significantly associated with the dependent variable, Economic resilience index.

Operational land holding, annual income and annual expenditure and Economic resilience index

The socio-economic variables operational land holding, annual income and annual expenditure are positively and significantly associated with the farmers' economic resilience index. The variables size of land holding, annual income and annual expenditure depicts the economic status of the family and enjoy the prestige in society. The economic resource, land holding is very much important to increase the farmers' disaster resilience level but sometimes it plays a contradictory role for ensuring sustainable agricultural production owing to its vulnerability to a wide range of farm disasters. Annual income and annual expenditure are completely inter-related with the farmers' economic resilience because if the income and expenditure are in imbalance then the entire family will face the problems of low level of economic resilience against various types naturally induced farm hazards. The annual income and expenditure are undoubtedly the essential determinants influencing economic resilience of a famer family. In comparison to high-

income households, the overall expenditures on various are limited in low-income households. Annual income is also found to be an essential factor in measuring economic resilience level at the household and individual level. The low annual income is connected to poor economic resilience level which leads to more vulnerable to disasters, poor living conditions and occurrence of food insecurity. The high annual income and expenditure group can minimize the risk of farm disasters through financial inclusion at household level. Therefore, the variables operational land holding, annual income and annual expenditure are positively and significantly associated with the farmers' economic resilience index.

Social participation, extension contact, mass media exposure, and training exposure and Economic resilience index

The extension-communication variables social participation, extension contact, mass media exposure, and training exposure are positively and significantly associated with the farmers' economic resilience index. These four extension-communication variables empowers the farming community to develop their insights through experiences and exposure. They play pivotal role to aware the farmer about the new agricultural technologies available in agricultural universities and research institutes to be utilized in local situation for bio-physical resource endowment and economic empowerment. Training makes individual perfect to utilize the skill in local situation. It empowers the farming community to make them able for application of adopted technologies for agricultural and economic development. Social participation, extension contact, mass media exposure and training are four determinants of information gathering, cosmopoliteness and venturesomeness. Due to these three possible outcomes the farmers are exposing themselves with their agricultural practices to the farm disaster resilience and vulnerability discourses. Though they have developed some logical mind set to cope the disasters but due to lack of adaptive capacity and adaptive technologies availability in the information network system, they are very much sensitive to various farm disasters. That is why the variables, social participation, extension contact, mass media exposure, and training exposure are positively and significantly associated with the farmers' economic resilience index.

Scientific orientation and Economic resilience index

Scientific orientation always is impacting upon the logical creation of mindset towards any innovative practices. The high level of scientific orientation among the farmer respondents develops the acumen for logical adoption of agricultural innovation. The technological

advancement in agriculture always banks upon economic profitability with the help of high external inputs involvement. The farmers with high scientific orientation go along with the advocated scientific technologies for profit maximization and increase their economic resilience towards various types of agricultural disasters. Therefore, the variable scientific orientation is positively and significantly associated with the dependent variable, economic resilience index according to the perception of farmer respondents.

Economic motivation and Economic resilience index

Economic motivation is a driving force of an individual to achieve the highest level of economic profit from an enterprise. The farmer respondents with high economic motivation always adopt the agricultural practices which have a high level of economic profit. Their thought process is always surrounding to enhance profitability from the farm. This leads to increasing their economic resilience to absorb the shock and bounce back from the impact of farm disaster. That is why the variable economic motivation is positively and significantly associated with the dependent variable, economic resilience index according to the perception of farmer respondents.

Risk bearing ability and Economic resilience index

Risk bearing ability makes an individual more venturesome and whimsical. The farmer respondents with high risk bearing ability takes much more risk applying agricultural technology for maximizing the production and profit that lead to economic development Those farmers are taking more risk to get more economic benefit and subsequently increase their economic resilience against various farm disasters. Consequently, those risk taker farmers are more resilient to disasters risk in agriculture. That is why the variable risk bearing ability is positively and significantly associated with the dependent variable, economic resilience index according to the perception of farmer respondents.

Management orientation and Economic resilience index

Management orientation is the degree to which a farmer is oriented towards scientific farm management comprising planning, production and marketing function of his or her farm. The farmer respondents with proper planning in various farm operations from land preparation to marketing of farm produce give them sustainable production and income. Moreover, more management-oriented farmers prepare a contingency plan; connect to the crop loans and insurances for averting the risk of any kind of farm disaster. This will enhance their economic resilience against impact of farm disasters. Therefore, the variable Management orientation is

positively and significantly associated with the dependent variable, economic resilience index according to the perception of farmer respondents.

Emotional intelligence and Economic resilience index

Emotional intelligence is undoubtedly the essential determinants influencing economic resilience of a farming family. Emotional intelligence comprising of self-awareness, emotion regulation, self-motivation ,social awareness ,social skills ,emotional receptivity play pivotal role in increasing economic resilience against various types of farm disasters. A socially aware and skilled; and self-motivated and emotionally controlled farmer can adjust in any kind of situation and avert the farm crisis situation such as flood, drought, hailstorm and pest and disease incidence. Consequently, the variable Emotional intelligence is positively and significantly associated with the dependent variable, economic resilience index according to the perception of farmer respondents.

6.3.2 Stepwise Regression: Economic resilience index vs. 18 causal variables

It is vivid from table 6.29 that the variables extension contact(X_{10}), economic motivation(X_{14}) and management orientation(X_{16}) are positively and significantly contributing towards characterizing the predicted variable economic resilience index. It is discernable that the economic motivation has exerted highest direct effect in case of characterizing the predicted variable, economic resilience index.

Table 6.29: Stepwise Regression: Economic resilience index vs. 18 causal variables

Sl. No.	Variables	Regression Coefficient B	S.E. of B	Beta	t-value	R^2
1.	Economic motivation(X_{14})	0.012	0.001	0.655	8.161**	0.467
2.	Extension contact(X_{10})	0.027	0.004	0.414	7.505**	
3.	Management orientation(X_{16})	0.004	0.001	0.348	4.367**	

** Significant at 1 % level, * Significant at 5% level

The R^2 value being 0.467, it is to infer that the eighteen predictor variables put together have explained 46.70% variation embedded with the predicted variable economic resilience index. Still 53.30% embedded with the predicted one remains unexplained. Thus it would be suggested that inclusion of some more contextual variables possessing direct bearing on the economic resilience index could have increased the level of explicability.



Fig.6.25: Diagrammatic representation of Stepwise Regression: Economic resilience index vs. 18 causal variables

Management orientation and Economic resilience index

Management orientation is a behavioural component of an individual which helps an individual to cope uncertainties within a short period of time with his/her presence of mind, contingency strategy and managerial ability. The farmer respondents with high level of management orientation may be exposed to a great level of risk related to his/her agricultural enterprise due to farm related disaster but with their management efficiency, presence of mind and the ability to adapt strategy for averting farm disaster risk may create an enabling environment for developing high level of adaptive capacity that enhances the farmers' economic resilience. As a result, those farmers do not face much difficulty in managing the farm related disasters. That is why the variable management orientation is positively and significantly contributing towards characterizing the predicted variable, economic resilience index. Also, one unit change of the variable management orientation is delineating the 0.004 unit change in the predicted variable. The variable management orientation is directly contributing 34.80% in case of characterizing the predicted variable, economic resilience index.

Economic motivation and Economic resilience index

Economic motivation is a driving force of an individual to achieve the highest level of economic profit from an enterprise. The farmer respondents with high economic motivation always adopt the agricultural practices which have a high level of economic profit. Their thought process is always surrounding to enhance profitability from the farm that leads to increase their economic resilience to absorb the shock and bounce back from the impact of farm disaster. That is why the variable Economic motivation is positively and significantly contributing towards characterizing the predicted variable, Economic resilience index. Also, one unit change of the variable

economic motivation is delineating the 0.012 unit change in the predicted variable. The variable economic motivation is directly contributing 65.50% in case of characterizing the predicted variable, economic resilience index.

Extension contact and Economic resilience index

Extension contact empowers the farming community to develop their insights through experiences and exposure. It plays pivotal role to aware the farmer about the new agricultural technologies available in agricultural universities and research institutes to be utilized in local situation for bio-physical resource endowment and economic empowerment. It is an important determinant of information gathering, cosmopoliteness and venturesomeness. Due to these three possible outcomes the farmers are exposing themselves with their agricultural practices to the farm disaster resilience. Though they have developed some logical mind set to cope the disasters but due to lack of adaptive capacity and adaptive technologies availability in the information network system, they are very much sensitive to various farm disasters. Therefore, the variable extension contact is positively and significantly contributing towards characterizing the predicted variable, economic resilience index. Also one unit change of the variable Extension contact is delineating the 0.027 unit change in the predicted variable. The variable extension contact is directly contributing 41.40% in case of characterizing the predicted variable, economic resilience index.

6.3.3 Coefficient of correlation(r) between Social resilience index (Y_2) and 18 causal variables

Table 6.30 reflects the Pearson's coefficient of correlation among the dependent variable i.e. social resilience index and 18 causal variables. The result shows that the variables namely cropping intensity**(**X_6) and management orientation**(**X_{16}), are positively and significantly associated with the dependent variable, social resilience index(Y_2). On the other hand, the variables viz., operational land holding**(**X_5), annual income**(**X_7), extension contact**(**X_{10}), and economic motivation**(**X_{14}) are negatively and significantly associated with the dependent variable, social resilience index(Y_2).

Table 6.30: Coefficient of correlation(r) between Social resilience index (Y_2) and 18 causal variables

Sl. No.	Variable	Coefficient of correlation(r)
Independent Variable		
Socio-personal variable		
1.	Age **(**X_1)	- 0.071
2.	Family education status **(**X_2)	0.074
3.	Farming experience**(**X_3)	-0.106
4.	Family size**(**X_4)	-0.054
Socio-economic variable		
5.	Operational land holding**(**X_5)	-0.286**
6.	Cropping intensity**(**X_6)	0.187**
7.	Annual income**(**X_7)	-0.156*
8.	Annual expenditure**(**X_8)	-0.128
Extension-communication variable		
9.	Social participation**(**X_9)	-0.056
10.	Extension contact**(**X_{10})	- 0.202**
11.	Mass media exposure**(**X_{11})	0.017
12.	Training exposure**(**X_{12})	-0.081
Socio-psychological variable		
13.	Innovativeness**(**X_{13})	-0.098
14.	Economic motivation**(**X_{14})	-0.166*
15.	Scientific orientation**(**X_{15})	0.082
16.	Management orientation**(**X_{16})	0.206**
17.	Risk bearing ability**(**X_{17})	0.090
18.	Emotional intelligence**(**X_{18})	-0.095

** Significant at 1 % level, * Significant at 5% level

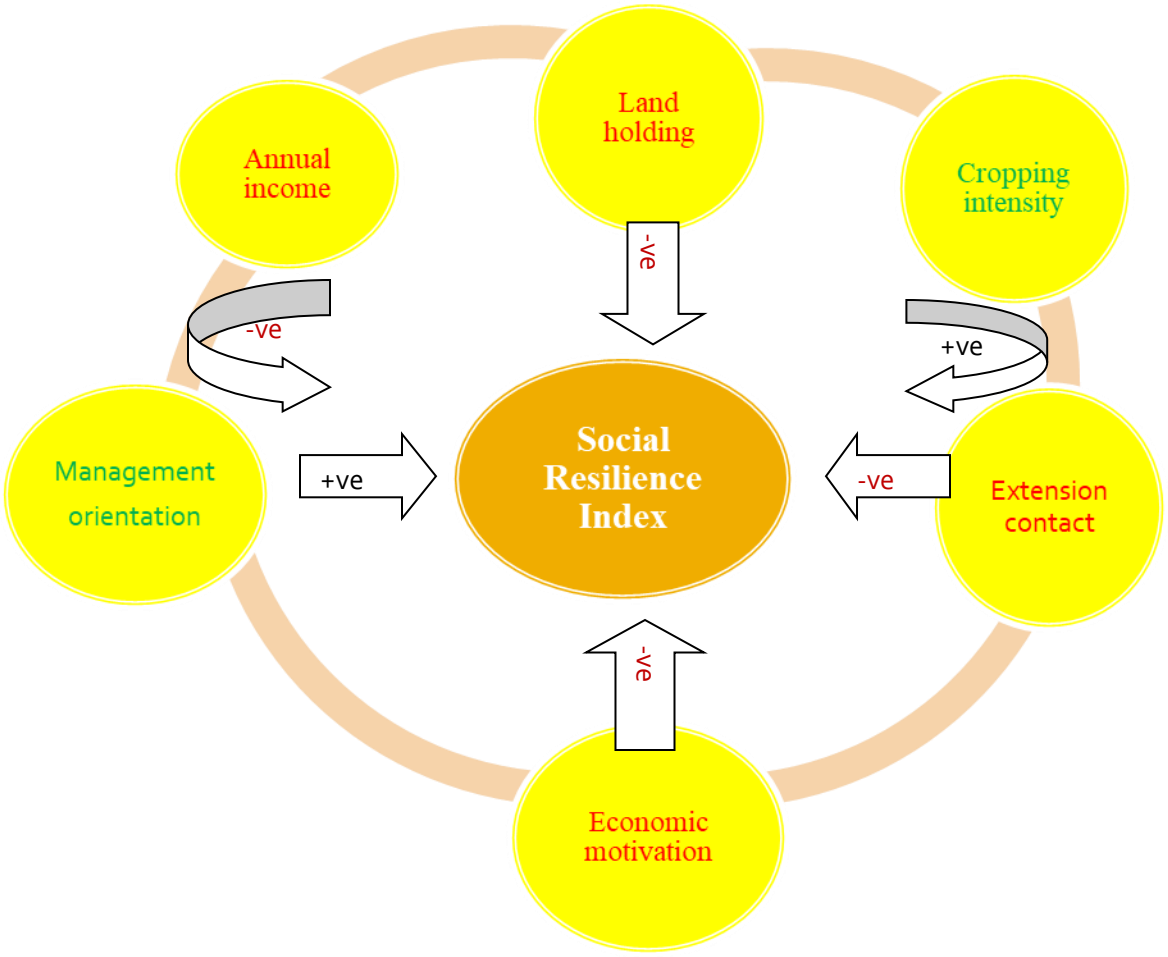


Fig.6.26: Diagrammatic representation of Coefficient of correlation(r) between Social resilience index (Y_2) and 18 causal variables

Cropping intensity and Social Resilience Index

Cropping intensity plays important role in enhancing the farmers' social resilience. Logically increased gross crop area or cropping intensity tends to higher agricultural production leading to more income and social resilience of farmers. Social resilience index is conceptualized as the status of the household contribution to farm labour, activeness in any farmer based organization ,availability of public awareness programmes on flood/drought/storm disaster etc. , access to extension and advisory service, access to basic services, availability of social safety net and others related indicators. As cropping intensity increases, the farmers tend to have more communication with extension and advisory service to manage their crops, and more access to

basic services and social safety net that lead to social resilience against farm disasters. Available public awareness programmes on flood/drought/storm disaster etc motivate farmers in increasing cropping intensity in disaster prone areas. Therefore, the variable cropping intensity is positively and significantly associated with the dependent variable, social resilience index.

Management orientation and Social Resilience Index

Management orientation is a behavioural component of an individual which helps an individual to cope uncertainties within a short period of time with his/her presence of mind, contingency strategy and managerial ability. The farmer respondents with high level of management orientation may be exposed to a great level of risk related to his/her agricultural enterprise due to farm related disaster but with their management efficiency, presence of mind and the ability to adapt strategy for averting farm disaster risk may create an enabling environment for developing high level of adaptive capacity that enhances the farmers' social resilience. As management orientation increases, the farmers tend to have more communication to extension and advisory service to manage their crops, and more access to basic services and social safety net that lead to social resilience against farm disasters. Therefore, the variable, management orientation is positively and significantly associated with the dependent variable, social resilience index.

Operational land holding and Social Resilience Index

Operational land holding indicates the size of the field used for agricultural activity. It is quite natural in the rural societies that the farmers having larger land holding are usually considered as resource rich farmers. Therefore, a farmer with larger size of operational land holding has already developed a strong rapport with different farmer based organization and institutions and accessed basic service, social safety net and extension services etc where they get the opportunity of increasing social resilience against various types of disaster. As a result, such type of farmer shows lesser interest for the resilient development activity to avert the risk of farm disaster which they have already developed. On the other hand, the farmers who have relatively smaller land holding are more interested for accessing to organization, basic service, social safety net and–extension services etc where they get the opportunity of increasing social resilience against various types of disaster. Therefore, the variable operational land holding is negatively and significantly associated with the dependent variable, social resilience index.

Annual income and Social Resilience Index

Annual income of a household implies the earnings of that particular household in a year which they get from their primary as well as secondary occupation. It happens in reality that a person or a family whose income is more will be more inclined towards any activity or scheme which would help in enhancing their income. Therefore, a farmer with high annual income has already developed a strong rapport with different farmer based organization and institutions and accessed basic service, social safety net and extension services etc where they get the opportunity of increasing social resilience against various types of disaster. As a result, such type of farmer shows lesser interest for the social resilient development against farm disaster which they have already developed. On the other hand, the farmers who have relatively low annual income are more interested for accessing to organization, basic service, social safety net and–extension services etc where they get the opportunity of increasing social resilience against various types of disaster. Therefore, the variable annual income is negatively and significantly associated with the dependent variable, social resilience index.

Extension contact and Social Resilience Index

Extension contact refers to the frequency of contact between the farmer respondents and the extension personnel like ADO, VLEW, KVK scientist, ATMA personnel, private extension personnel, NGO personnel, etc. within a specified period of time. Extension contact empowers the farming community to develop their insights through experiences and exposure. It plays pivotal role to aware the farmer about the new agricultural technologies available in agricultural universities and research institutes to be utilized in local situation. Therefore, a farmer with high extension contact has already developed a strong rapport with different farmer based organization and institutions and accessed basic service, social safety net and extension services etc where they get the opportunity of increasing social resilience against various types of disaster. As a result, such type of farmer shows lesser interest for the social resilient development against farm disaster which they have already developed. On the other hand, the farmers who have relatively low extension contact are more interested for accessing to organization, basic service, social safety net and extension services etc where they get the opportunity of increasing social resilience against various types of farm disaster. Therefore, the variable extension contact is negatively and significantly associated with the dependent variable, social resilience index.

Economic motivation and Social Resilience Index

Economic motivation is a driving force of an individual to achieve the highest level of economic profit from an enterprise. The farmer respondents with high economic motivation always adopt the agricultural practices which have a high level of economic profit. Therefore, a farmer with high level of economic motivation has already developed a strong rapport with different farmer based organization and institutions and accessed basic service ,social safety net and extension services etc where they get the opportunity of increasing social resilience against various types of disaster. As a result, such type of farmer shows lesser interest for the social resilient development against farm disaster which they have already developed. On the other hand, the farmers who have relatively low economic motivation are more interested for accessing to organization, basic service, social safety net and extension services etc where they get the opportunity of increasing social resilience against various types of farm disaster. Therefore, the variable economic motivation is negatively and significantly associated with the dependent variable, social resilience index.

6.3.4 Stepwise Regression: Social resilience index vs. 18 causal variables

It is observable from table 6.31 that the variable management orientation(X_{16}) and scientific orientation(X_{15}) are positively and significantly contributing towards characterizing the predicted variable, social resilience index while other three variables namely operational land holding(X_{05}), economic motivation(X_{14}) and farming experience(X_{03}) are negatively and significantly contributing towards characterizing the predicted variable, social resilience index

It is discernable that the management orientation has exerted highest direct effect in case of characterizing the predicted variable, economic resilience index.

Table 6.31: Stepwise Regression: Social resilience index vs. 18 causal variables

Sl. No.	Variables	Regression Coefficient B	S.E.B	Beta	t-value	R^2
1.	Operational land holding(X_{05})	-0.024	0.005	-0.360	-4.804**	0.453
2.	Management orientation(X_{16})	0.011	0.001	1.121	9.411**	
3.	Economic motivation(X_{14})	-0.012	0.002	-0.703	-6.692**	
4.	Farming experience(X_{03})	-0.001	0.000	-0.266	-3.553**	
5.	Scientific orientation(X_{15})	0.004	0.002	0.313	2.547*	

** Significant at 1 % level, * Significant at 5% level

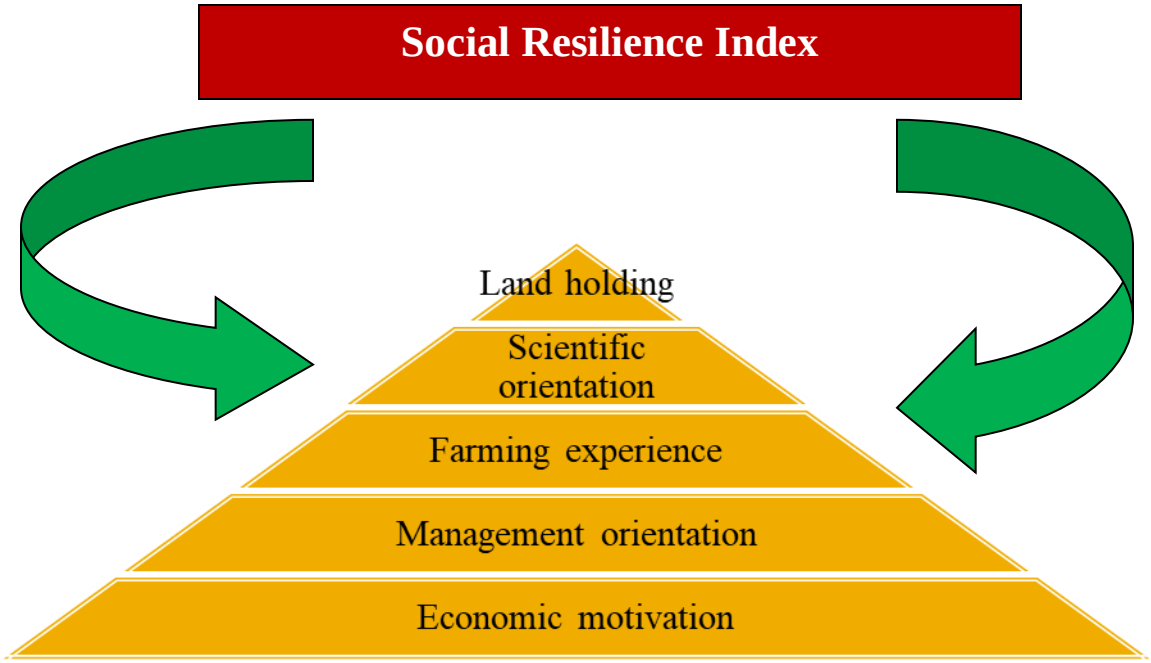


Fig.6.27: Diagrammatic representation of Stepwise Regression: Social resilience index vs. 18 causal variables

The R^2 value being 0.453, it is to infer that the eighteen predictor variables put together have explained 45.30% variation embedded with the predicted variable economic resilience index. Still 54.70% embedded with the predicted one remains unexplained. Thus it would be suggested that inclusion of some more contextual variables possessing direct bearing on the social resilience index could have increased the level of explicability.

Management orientation and Social Resilience Index

Management orientation is a behavioural component of an individual which helps an individual to cope uncertainties within a short period of time with his/her presence of mind, contingency strategy and managerial ability. The farmer respondents with high level of management orientation may be exposed to a great level of risk related to his/her agricultural enterprise due to farm related disaster but with their management efficiency, presence of mind and the ability to adapt strategy for averting farm disaster risk may create an enabling environment for developing high level of adaptive capacity that enhances the farmers' social resilience. As a result those farmers do not face much difficulty in managing the farm related disasters. That is why the

variable management orientation is positively and significantly contributing towards characterizing the predicted variable, social resilience index.

Scientific orientation and Social Resilience Index

Scientific orientation always is impacting upon the logical creation of mindset towards any innovative practices. The high level of scientific orientation among the farmer respondents develops the acumen for logical adoption of agricultural innovation. The technological advancement in agriculture always banks upon economic profitability with the help of high external inputs involvement. The farmers with high scientific orientation go along with the advocated scientific technologies for profit maximization and increase their socio-economic resilience towards various types of agricultural disasters. As a result those farmers do not face much difficulty in managing the farm related disasters .As scientific orientation increases, the farmers tend to have more communication with extension and advisory service to manage their farm enterprises, and more access to basic services and social safety net that lead to social resilience against farm disasters. Available public awareness programmes on flood/drought/storm disaster etc motivate farmers in increasing scientific orientation in disaster prone areas. Therefore, the variable, scientific orientation is positively and significantly contributing towards characterizing the predicted variable, social resilience index. Also one unit change of the variable scientific orientation is delineating the 0.004unit change in the predicted variable. The variable scientific orientation is directly contributing 31.30% in case of characterizing the predicted variable, social resilience index.

Economic motivation and Social Resilience Index

Economic motivation is a driving force of an individual to achieve the highest level of economic profit from an enterprise. The farmer respondents with high economic motivation always adopt the agricultural practices which have a high level of economic profit. Therefore, a farmer with high level of economic motivation has already developed a strong rapport with different farmer based organization and institutions and accessed basic service ,social safety net and extension services etc where they get the opportunity of increasing social resilience against various types of disaster. As a result, such type of farmer shows lesser interest for the social resilient development against farm disaster which they have already developed. On the other hand, the farmers who have relatively low economic motivation are more interested for accessing to organization, basic service, social safety net and extension services etc where they get the opportunity of increasing

social resilience against various types of farm disaster. Therefore, the variable economic motivation is negatively and significantly contributing towards characterizing the predicted variable, social resilience index. Also one unit change of the variable economic motivation is delineating the 0.012 unit change in the predicted variable. The variable economic motivation is directly contributing 70.30% in case of characterizing the predicted variable, social resilience index.

Farming experience and Social Resilience Index

The farming experience of the farmer respondents reflect the age-old experience about the production, protection and marketing practices of the agricultural produces. Logically, if age increases the traditional farming experiences also increases. More experienced farmers are not at all concerned about the organization and institutions membership. , availability of basic service, social safety net and extension services. Therefore, a farmer with more farming experiences has already developed a strong rapport with different farmer based organization and institutions and accessed basic service, social safety net and extension services etc where they get the opportunity of increasing social resilience against various types of disaster. As a result, such type of farmer shows lesser interest for the social resilient development against farm disaster which they have already developed. On the other hand, the farmers who have relatively less farming experiences are more interested for accessing to organization, basic service, social safety net and extension services etc where they get the opportunity of increasing social resilience against various types of farm disaster. Therefore, the variable, farming experiences is negatively and significantly contributing towards characterizing the predicted variable, social resilience index. Also one unit change of the variable economic motivation is delineating the 0.001unit change in the predicted variable. The variable, size of land holding is directly contributing 31.30% in case of characterizing the predicted variable, social resilience index.

Operational land holding and Social Resilience Index

Size of land holding depicts the economic status of the family and enjoys the prestige in society. The economic resource, land holding is very much important to increase the farmers' disaster resilience level but sometimes it plays a contradictory role for ensuring sustainable agricultural production owing to its vulnerability to a wide range of farm disasters. The farmer respondents with large size of land holding always adopt the agricultural practices which have a high level of economic profit with various farm enterprises. Therefore, a farmer with large size of land

holding has already developed a strong rapport with different farmer based organization and institutions and accessed basic service, social safety net and extension services etc where they get the opportunity of increasing social resilience against various types of disaster. As a result, such type of farmer shows lesser interest for the social resilient development against farm disaster which they have already developed. On the other hand, the farmers who have relatively small size of land holding are more interested for accessing to organization, basic service, social safety net and extension services etc where they get the opportunity of increasing social resilience against various types of farm disaster. Therefore, the variable, size of land holding is negatively and significantly contributing towards characterizing the predicted variable, social resilience index. Also, one unit change of the variable economic motivation is delineating the 0.024 unit change in the predicted variable. The variable, size of land holding is directly contributing 36.00% in case of characterizing the predicted variable, social resilience index.

6.3.5 Coefficient of correlation(r) between Technical resilience index (Y_3) and 18 causal variables

Table 6.32 presents the Pearson's coefficient of correlation among the dependent variable i.e. technical resilience index and 18 causal variables. The result shows that the variables namely operational land holding**(**X_5), annual income**(**X_7), annual expenditure**(**X_8), social participation**(**X_9), extension contact**(**X_{10}), mass media exposure**(**X_{11}), training exposure**(**X_{12}), innovativeness**(**X_{13}), economic motivation**(**X_{14}), scientific orientation**(**X_{15}), management orientation**(**X_{16}), risk bearing ability**(**X_{17}) and emotional intelligence**(**X_{18}), are positively and significantly associated with the dependent variable, technical resilience index(Y_3).On the other hand, the variables viz., farming experience**(**X_3) and cropping intensity**(**X_6) are negatively and significantly associated with the dependent variable, technical resilience index(Y_3).

Table 6.32: Coefficient of correlation(r) between Technical resilience index (Y_3) and 18 causal variables

Sl. No.	Variable	Coefficient of correlation(r)
Independent Variable		
Socio-personal variable		
1.	Age (X_1)	-0.061
2.	Family education status (X_2)	0.097
3.	Farming experience(X_3)	-0.153*
4.	Family size(X_4)	-0.059
Socio-economic variable		
5.	Operational land holding(X_5)	0.529**
6.	Cropping intensity(X_6)	-0.404**
7.	Annual income(X_7)	0.548**
8.	Annual expenditure(X_8)	0.523**
Extension-communication variable		
9.	Social participation(X_9)	0.316**
10.	Extension contact(X_{10})	0.323**
11.	Mass media exposure(X_{11})	0.528**
12.	Training exposure(X_{12})	0.273**
Socio-psychological variable		
13.	Innovativeness(X_{13})	0.160*
14.	Economic motivation(X_{14})	0.565**
15.	Scientific orientation(X_{15})	0.629**
16.	Management orientation(X_{16})	0.499**
17.	Risk bearing ability(X_{17})	0.470**
18.	Emotional intelligence(X_{18})	0.459**

** Significant at 1 % level, * Significant at 5% level

Farming experience and Technical resilience index

The farming experience of the respondents reflects the age-old experience about the production, protection and marketing practices of the agricultural produces. Logically, if age increases the traditional farming experiences also increases. More experienced farmers are not at all concerned about the knowledge of flood and drought resistant varieties, early maturing crop varieties, intercropping, relay cropping, integrated farming system, unconventional production practices, modern plant protection technologies, daily weather data, flood/drought/storm disaster warning etc which can be adaptation strategies for enhancing farmers' technical resilience against various types of disasters. In contrary the less farming experienced farmers have the innovative approaches to flood and drought resistant varieties, early maturing crop varieties, intercropping, relay cropping, integrated farming system, unconventional production practices, modern plant

protection technologies, daily weather data, flood/drought/storm disaster warning etc. and learn and utilize the adaptation technologies in their local situation to increase resilience level by averting the risk of farm disaster. Consequently, the variable farming experience is negatively and significantly associated with the dependent variable technical resilience index.

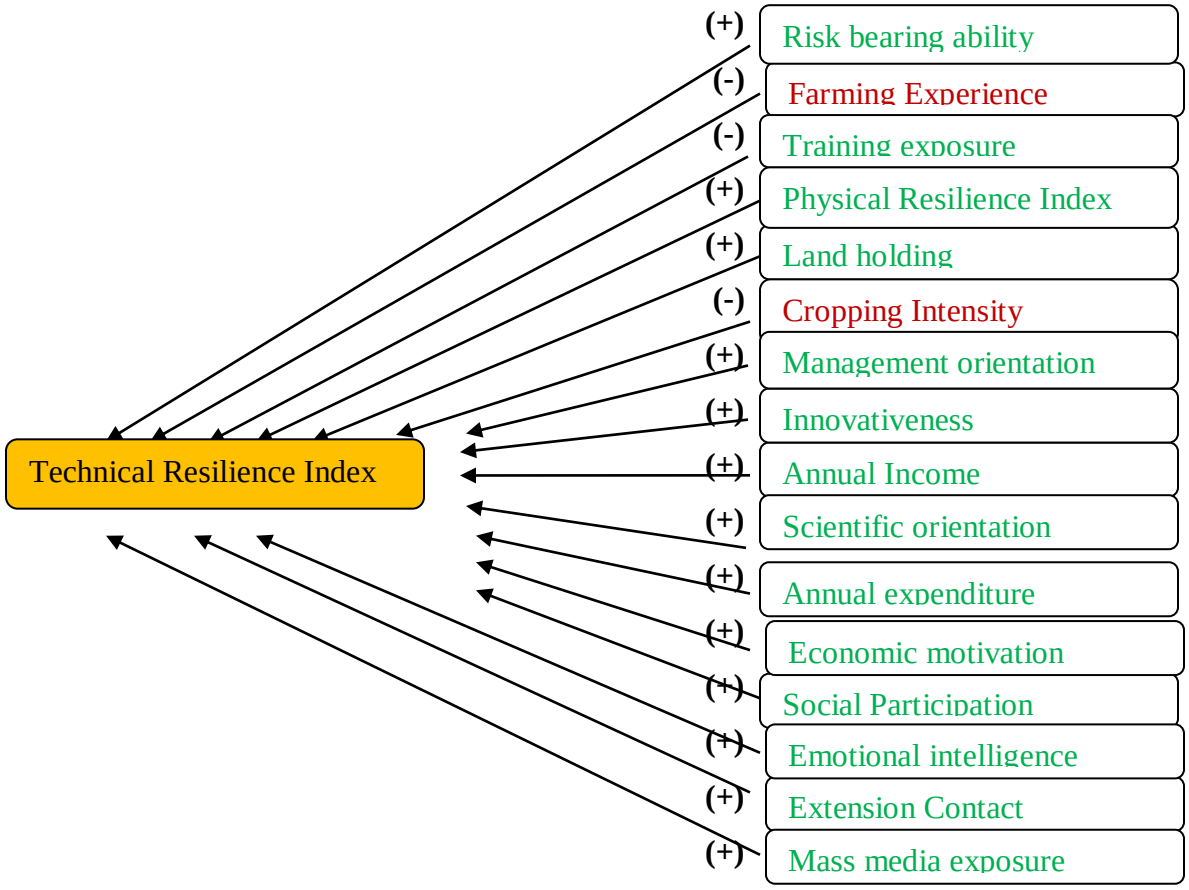


Fig. 6.28: Diagrammatic representation of Coefficient of correlation(r) between Technical resilience index (Y_3) and 18causal variables

Cropping intensity and Technical resilience index

Cropping intensity plays important role in enhancing the farmers' technical resilience. Logically increased gross crop area or cropping intensity tends to higher agricultural production leading to more income and technical resilience of farmers. It is observable that farmers having more cropping intensity are not at all concerned about the knowledge of flood and drought resistant varieties, early maturing crop varieties, intercropping, relay cropping, integrated farming system, unconventional production practices, modern plant protection technologies, daily weather data,

flood/drought/storm disaster warning etc which can be adaptation strategies for enhancing farmers' technical resilience against various types of disasters. Therefore, a farmer with more cropping intensity is already familiar to flood and drought resistant varieties, early maturing crop varieties, intercropping, relay cropping, integrated farming system, unconventional production practices, modern plant protection technologies, daily weather data, flood/drought/storm disaster warning etc. As a result, such type of farmer shows lesser interest for the technical resilient development against farm disaster which they have already developed. Therefore, the variable cropping intensity is negatively and significantly associated with the dependent variable, technical resilience index.

Operational land holding, annual income and annual expenditure and Technical resilience index

The socio-economic variables operational land holding, annual income and annual expenditure are positively and significantly associated with the farmers' technical resilience index. The variables size of land holding, annual income and annual expenditure depicts the economic status of the family and enjoy the prestige in society. The economic resource, land holding is very much important to increase the farmers' disaster resilience level but sometimes it plays a contradictory role for ensuring sustainable agricultural production owing to its vulnerability to a wide range of farm disasters. Annual income and annual expenditure are completely inter-related with the farmers' technical resilience because if the income and expenditure are in imbalance then the entire family may face the problems of low level of technical resilience against various types naturally induced farm hazards. The annual income and expenditure are undoubtedly the essential determinants influencing technical resilience of a famer family. In comparison to high-income households, the overall expenditures on various agri inputs are limited in low-income households. Annual income is also found to be an essential factor in measuring technical resilience level at the household and individual level. The low annual income is connected to poor technical resilience which leads to more vulnerable to disasters, poor living conditions and occurrence of food insecurity. The high annual income and expenditure group can minimize the risk of farm disasters through adopting flood and drought resistant varieties, early maturing crop varieties, intercropping, relay cropping, integrated farming system, unconventional production practices, modern plant protection technologies and accessing daily weather data, flood/drought/storm disaster warning etc. Therefore, the variables operational land holding,

annual income and annual expenditure are positively and significantly associated with the farmers' technical resilience index.

Social participation, extension contact, mass media exposure, and training exposure and Technical resilience index

The extension-communication variables social participation, extension contact, mass media exposure, and training exposure are positively and significantly associated with the farmers' technical resilience index. These four extension-communication variables empowers the farming community to develop their insights through experiences and exposure .They play pivotal role to aware the farmer about the new agricultural technologies available in agricultural universities and research institutes to be utilized in local situation for bio-physical resource endowment and technical empowerment. Training makes individual perfect to utilize the skill in local situation. It empowers the farming community to make them able for application of technologies for agricultural and economic development. Social participation, extension contact, mass media exposure and training are four determinants of information gathering, cosmopoliteness and venturesomeness. Due to these three possible outcomes the farmers are exposing themselves with their agricultural practices to the farm disaster resilience and vulnerability discourses. Though they have developed some logical mind set to cope the disasters but due to lack of adaptive capacity and adaptive technologies availability in the information network system, they are very much sensitive to various farm disasters. That is why the variables, social participation, extension contact, mass media exposure, and training exposure are positively and significantly associated with the farmers' technical resilience index.

Scientific orientation and Technical resilience index

Scientific orientation always is impacting upon the logical creation of mindset towards any innovative practices. The high level of scientific orientation among the farmer respondents develops the acumen for logical adoption of agricultural innovation. The technological advancement in agriculture always banks upon economic profitability with the help of high external inputs involvement. The farmers with high scientific orientation go along with the advocated scientific technologies for profit maximization and increase their technical resilience towards various types of agricultural disasters. Therefore, the variable scientific orientation is positively and significantly associated with the dependent variable, technical resilience index according to the perception of farmer respondents.

Economic motivation and Technical resilience index

Economic motivation is a driving force of an individual to achieve the highest level of economic profit from an enterprise. The farmer respondents with high economic motivation always adopt the agricultural practices which have a high level of economic profit and technically feasible in local situation. Their thought process is always surrounding to enhance profitability from the farm using the appropriate farm technologies. This will lead to increase their technical resilience to absorb the shock and bounce back from the impact of farm disaster. That is why the variable economic motivation is positively and significantly associated with the dependent variable, technical resilience index according to the perception of farmer respondents.

Risk bearing ability and Technical resilience index

Risk bearing ability makes an individual more venturesome and whimsical. The farmer respondents with high risk bearing ability takes much more risk applying agricultural technology for maximizing the production and profit in any unpredictable bio physical situations which lead their technical resilience development. Those farmers are taking more risk to get more economic benefit by applying farm disaster mitigation technologies, subsequently develop their technical resilience against various farm disasters. Consequently, those risk taker farmers are more resilient to disasters risk in agriculture. That is why the variable risk bearing ability is positively and significantly associated with the dependent variable, technical resilience index according to the perception of farmer respondents.

Management orientation and Technical resilience index

Management orientation is the degree to which a farmer is oriented towards scientific farm management comprising planning, production and marketing function of his or her farm. The farmer respondents with proper planning in various farm operations from land preparation to marketing of farm produce and unexpected farm disasters realize sustainable production and income. Moreover, more management-oriented farmers prepare a contingency plan, adopt farm disaster mitigating technologies and uses weather data and flood/drought/storm disaster warning etc.for averting the risk of any kind of farm disaster. This will enhance their technical resilience against impact of farm disasters. Therefore, the variable management orientation is positively and significantly associated with the dependent variable, technical resilience index according to the perception of farmer respondents.

Emotional intelligence and Technical resilience index

Emotional intelligence is undoubtedly the essential determinants influencing technical resilience of a farming family. Emotional intelligence comprising of self-awareness, emotion regulation, self-motivation, social awareness, social skills ,emotional receptivity play pivotal role in increasing technical resilience against farm disasters. A socially aware and skilled; and self-motivated and emotionally controlled farmer can adjust in any kind of situation and adopt farm disaster mitigating technologies and uses weather data and flood/drought/storm disaster warning etc earlier than the farmers with low level of emotional intelligence for averting the farm crisis situation such as flood , drought, hailstorm and pest and disease incidence etc. Consequently, the variable Emotional intelligence is positively and significantly associated with the dependent variable, technical resilience index according to the perception of farmer respondents.

6.3.6 Stepwise Regression: Technical resilience index vs. 18 causal variables

It is observable from table 6.33 that the variable scientific orientation(X_{15}), management orientation(X_{16}), age(X_{01}), economic motivation(X_{14}) and annual expenditure(X_{08}) are positively and significantly contributing towards characterizing the predicted variable, technical resilience index while other two variables namely training exposure(X_{12}) and cropping intensity(X_{06}) are negatively and significantly contributing towards characterizing the predicted variable, technical resilience index.

Table6.33: Stepwise Regression: Technical resilience index vs. 18 causal variables

Sl. No.	Variables	Regression Coefficient B	S.E. of B	Beta	t-value	R^2
1.	Scientific orientation(X_{15})	0.013	0.001	1.046	9.218**	0.583
2.	Management orientation(X_{16})	0.007	0.001	0.744	6.531**	
3.	Age(X_{01})	0.001	0.000	0.285	4.775**	
4.	Economic motivation(X_{14})	0.004	0.002	0.261	2.838**	
5.	Annual expenditure(X_{08})	0.027	0.007	0.294	4.039**	
6.	Training exposure(X_{12})	0.002	0.001	0.129	-2.371*	
7.	Cropping intensity(X_{06})	-0.057	0.029	-0.116	-1.983*	

** Significant at 1 % level, * Significant at 5% level

It is discernable that the scientific orientation has exerted highest direct effect in case of characterizing the predicted variable, technical resilience index.

The R^2 value being 0.583, it is to infer that the eighteen predictor variables put together have explained 58.30% variation embedded with the predicted variable economic resilience index.

Still 41.70% embedded with the predicted one remains unexplained. Thus it would be suggested that inclusion of some more contextual variables possessing direct bearing on the social resilience index could have increased the level of explicability.

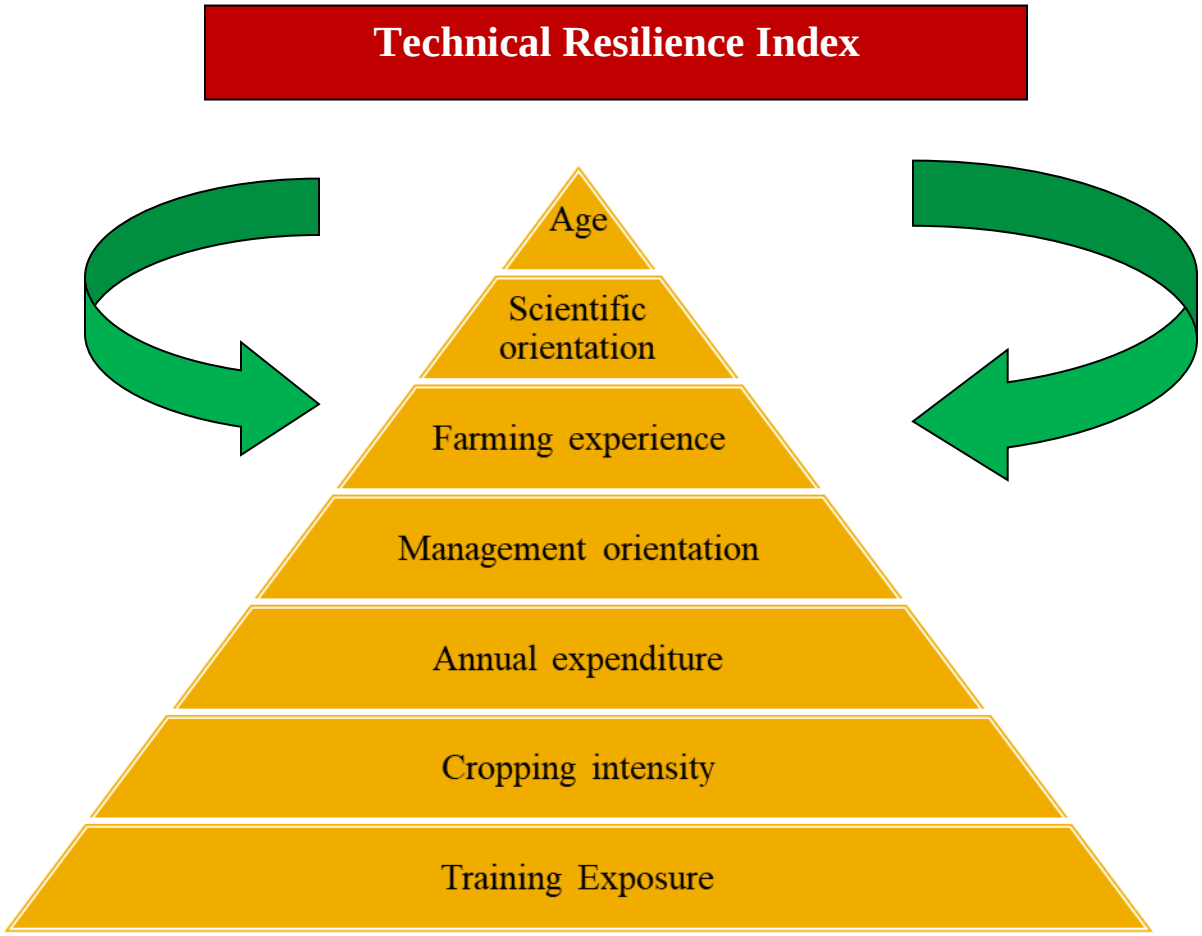


Fig.6.29: Diagrammatic representation of Stepwise Regression: Technical resilience index vs. 18 causal variables

Scientific orientation and Technical resilience index

Scientific orientation always is impacting upon the logical creation of mindset towards any innovative practices. The high level of scientific orientation among the farmer respondents develops the acumen for logical adoption of agricultural innovation. The technological advancement in agriculture always banks upon economic profitability with the help of high external inputs involvement. The farmers with high scientific orientation go along with the advocated scientific technologies for profit maximization and increase their technical resilience towards various types of agricultural disasters. As a result those farmers do not face much

difficulty in managing the farm related disasters. As scientific orientation increases, the farmers tend to gain the knowledge of flood and drought resistant varieties, early maturing crop varieties, intercropping, relay cropping, integrated farming system, unconventional production practices, modern plant protection technologies, daily weather data, flood/drought/storm disaster warning etc which can be adaptation strategies for enhancing farmers' technical resilience against various types of farm disasters. Therefore, the variable, scientific orientation is positively and significantly contributing towards characterizing the predicted variable, technical resilience index.

Management orientation and Technical resilience index

Management orientation is the degree to which a farmer is oriented towards scientific farm management comprising planning, production and marketing function of his or her farm. The farmer respondents with proper planning in various farm operations from land preparation to marketing of farm produce and unexpected farm disasters realize sustainable production and income. Moreover, more management-oriented farmers prepare a contingency plan, adopt farm disaster mitigating technologies and uses weather data and flood/drought/storm disaster warning etc. for averting the risk of any kind of farm disaster. This will enhance their technical resilience against impact of farm disasters. Therefore, the variable, management orientation is positively and significantly contributing towards characterizing the predicted variable, technical resilience index. Also, one unit change of the variable scientific orientation is delineating the 0.007 unit change in the predicted variable. The variable scientific orientation is directly contributing 74.40% in case of characterizing the predicted variable, technical resilience index.

Age and Technical resilience index

Age is the reflection of gathering experiences by an individual. The age of the farmer is an essential factor in decision-making for the family. An increase in age of farmer with a high-risk bearing capacity increases technical resilience, as compared to the young aged farmers. Since the elderly farmers are being engaged in farming activities for long period of time for ensuring the sustainable agricultural production, an increase in age affects the technical resilience of the farmers. Due to long association with the agricultural production system, the aged farmers learn and develop technical knowledge to cope the situation of farm disasters .The aged farmers learn and adopt flood/drought tolerant ,early maturity crop varieties and other adaptive farm practices to escape the disaster like situations. They are able to learn about the coping technological strategies for averting disaster risk in farming. These aged farmers are expected to engage

actively on large-scale agricultural production system to make it more profitable by practising the adaptive technologies for averting the risk of farm disaster. Therefore, the variable age is positively and significantly contributing towards characterizing the predicted variable, Technical resilience index. Also, one unit change of the variable age is delineating the 0.001unit change in the predicted variable. The variable age is directly contributing 28.5% in case of characterizing the predicted variable, Technical resilience index.

Economic motivation and Technical resilience index

Economic motivation is a driving force of an individual to achieve the highest level of economic profit from an enterprise. The farmer respondents with high economic motivation always adopt the agricultural practices which have a high level of economic profit and technically feasible in local situation. Their thought process is always surrounding to enhance profitability from the farm using the appropriate farm technologies. The farmers with high level of economic motivation have quest for gaining knowledge of flood and drought resistant varieties, early maturing crop varieties, intercropping, relay cropping, integrated farming system, unconventional production practices, modern plant protection technologies, daily weather data, flood/drought/storm disaster warning etc which can be adaptation strategies for enhancing farmers' technical resilience against various types of farm disasters. Therefore, the variable, economic motivation is positively and significantly contributing towards characterizing the predicted variable, technical resilience index. Also one unit change of the variable scientific orientation is delineating the 0.004 unit change in the predicted variable. The variable scientific orientation is directly contributing 26.10% in case of characterizing the predicted variable, technical resilience index.

Annual expenditure and Technical resilience index

The socio-economic variable annual expenditure depicts the economic status of the family and enjoys the prestige in society. Annual income and annual expenditure are completely inter-related with the farmers' technical resilience because if the income and expenditure are in imbalance then the entire family may face the problems of low level of technical resilience against various types naturally induced farm hazards. In comparison to high-income households, the overall expenditures on various agri inputs are limited in low-income households. Logically high income tends to high expenditure. The high annual income and expenditure group can minimize the risk of farm disasters through adopting flood and drought resistant varieties, early maturing crop varieties, intercropping, relay cropping, integrated farming system,

unconventional production practices, modern plant protection technologies and accessing daily weather data, flood/drought/storm disaster warning etc. Expenditure on adoption of farm disaster mitigation technologies and practices comparatively more than farmers' production practices. Therefore, the variable, annual expenditure is positively and significantly contributing towards characterizing the predicted variable, technical resilience index. Also, one unit change of the variable scientific orientation is delineating the 0.027unit change in the predicted variable. The variable scientific orientation is directly contributing 29.40% in case of characterizing the predicted variable, technical resilience index.

Training exposure and Technical resilience index

The extension-communication variable training exposure empowers the farming community to develop their insights through experiences and exposure. It plays pivotal role to aware the farmer about the new agricultural technologies available in agricultural universities and research institutes to be utilized in local situation for bio-physical resource endowment and technical empowerment. Training makes individual perfect to utilize the knowledge and skill in local situation. It empowers the farming community to make them able for application of technologies for agricultural and economic development. Training is also considered as determinants of information gathering, cosmopoliteness and venturesomeness. Due to these three possible outcomes the farmers are exposing themselves with their agricultural practices to the farm disaster resilience and vulnerability discourses. It is observable that farmers with more training exposure are not at all concerned about the knowledge of flood and drought resistant varieties, early maturing crop varieties, intercropping, relay cropping, integrated farming system, unconventional production practices, modern plant protection technologies, daily weather data, flood/drought/storm disaster warning etc which can be adaptation strategies for enhancing farmers' technical resilience against various types of disasters. It may be, a farmer with more training exposure is already familiar to flood and drought resistant varieties, early maturing crop varieties, intercropping, relay cropping, integrated farming system, unconventional production practices, modern plant protection technologies, daily weather data, flood/drought/storm disaster warning etc. As a result, such type of farmer shows lesser interest for the technical resilient development against farm disaster which they have already developed. On the other hand, the farmers who have relatively low level of training exposure are more interested in adopting farm disaster mitigating technologies and using weather data and flood/drought/storm disaster warning

etc where they get the opportunity for increasing technical resilience against various types of farm disaster. Therefore, the variable, training exposure is negatively and significantly contributing towards characterizing the predicted variable, technical resilience index. Also one unit change of the variable training exposure is delineating the 0.002unit change in the predicted variable. The variable training exposure is directly contributing 12.90% in case of characterizing the predicted variable, technical resilience index.

Cropping intensity and Technical resilience index

Cropping intensity plays important role in enhancing the farmers' technical resilience. Logically increased cropping intensity tends to higher agricultural production leading to more income and technical resilience of farmers. It is observable that farmers having more cropping intensity are not at all concerned about the knowledge of flood and drought resistant varieties, early maturing crop varieties, intercropping, relay cropping, integrated farming system, unconventional production practices, modern plant protection technologies, daily weather data, flood/drought/storm disaster warning etc which can be adaptation strategies for enhancing farmers' technical resilience against various types of disasters. It may be, a farmer with more cropping intensity is already familiar to flood and drought resistant varieties, early maturing crop varieties, intercropping, relay cropping, integrated farming system, unconventional production practices, modern plant protection technologies, daily weather data, flood/drought/storm disaster warning etc. As a result, such type of farmer shows lesser interest for the technical resilient development against farm disaster which they have already developed.

Therefore, the variable, cropping intensity is negatively and significantly contributing towards characterizing the predicted variable, technical resilience index. Also, one unit change of the variable scientific orientation is delineating the 0.057 unit change in the predicted variable. The variable scientific orientation is directly contributing 11.6% in case of characterizing the predicted variable, technical resilience index.

6.3.7 Coefficient of correlation(r) between Physical resilience index (Y_4) and 18 causal variables

Table 6.34 reflects the Pearson's coefficient of correlation among the dependent variable i.e. physical resilience index and 18causal variables. The result shows that the variables namely age **(**X_1), family education**(**X_2), farming experience**(**X_3),operational land holding**(**X_5), annual income**(**X_7), annual expenditure**(**X_8), social participation**(**X_9), extension contact**(**X_{10}), mass media exposure**(**X_{11}), training exposure**(**X_{12}), innovativeness**(**X_{13}) and emotional

intelligence(X_{18}), are positively and significantly associated with the dependent variable, physical resilience index(Y_4).On the other hand, the variable cropping intensity(X_6) is negatively and significantly associated with the dependent variable, physical resilience index(Y_4).

Table 6.34: Coefficient of correlation(r) between Physical resilience index (Y_4) and 18 causal variables

Sl. No.	Variable	Coefficient of correlation(r)
Independent Variable		
Socio-personal variable		
1.	Age (X_1)	0.293**
2.	Family education status (X_2)	0.281**
3.	Farming experience(X_3)	0.252**
4.	Family size(X_4)	0.058
Socio-economic variable		
5.	Operational land holding(X_5)	0.374**
6.	Cropping intensity(X_6)	-0.233**
7.	Annual income(X_7)	0.284**
8.	Annual expenditure(X_8)	0.299**
Extension-communication variable		
9.	Social participation(X_9)	0.200**
10.	Extension contact(X_{10})	0.447**
11.	Mass media exposure(X_{11})	0.197**
12.	Training exposure(X_{12})	0.367**
Socio-psychological variable		
13.	Innovativeness(X_{13})	0.159*
14.	Economic motivation(X_{14})	0.014
15.	Scientific orientation(X_{15})	0.026
16.	Management orientation(X_{16})	0.049
17.	Risk bearing ability(X_{17})	0.134
18.	Emotional intelligence(X_{18})	0.168*

** Significant at 1 % level, * Significant at 5% level

Age and Physical resilience index

In the present study, the variable 'age' has been conceptualized as the chronological age of the farmer respondent. The age of the farmer is an essential factor in decision-making for the family. Age is the reflection of gathering experiences by an individual. An increase in age of farmer with a high risk bearing capacity increases physical resilience, as compared to the young aged farmers. Since the elderly farmers are being engaged in farming activities for long period of time for ensuring the sustainable agricultural production and subsequently develop physical

infrastructure in the farm. They maintain long term land tenure system and try to develop drainage and irrigation system, road and farm electricity over a period of time. An increase in age affects the physical resilience of the farmers. Due to long association with the agricultural production system, the aged farmers learn and develop physical infrastructure and maintain concrete land tenure system in the farm to cope the situation of farm disasters .With long farming experiences, they are able to learn about the coping technological strategies with the available physical infrastructure for averting disaster risk in farming. Therefore, the variable age is positively and significantly associated with the dependent variable, physical resilience index.

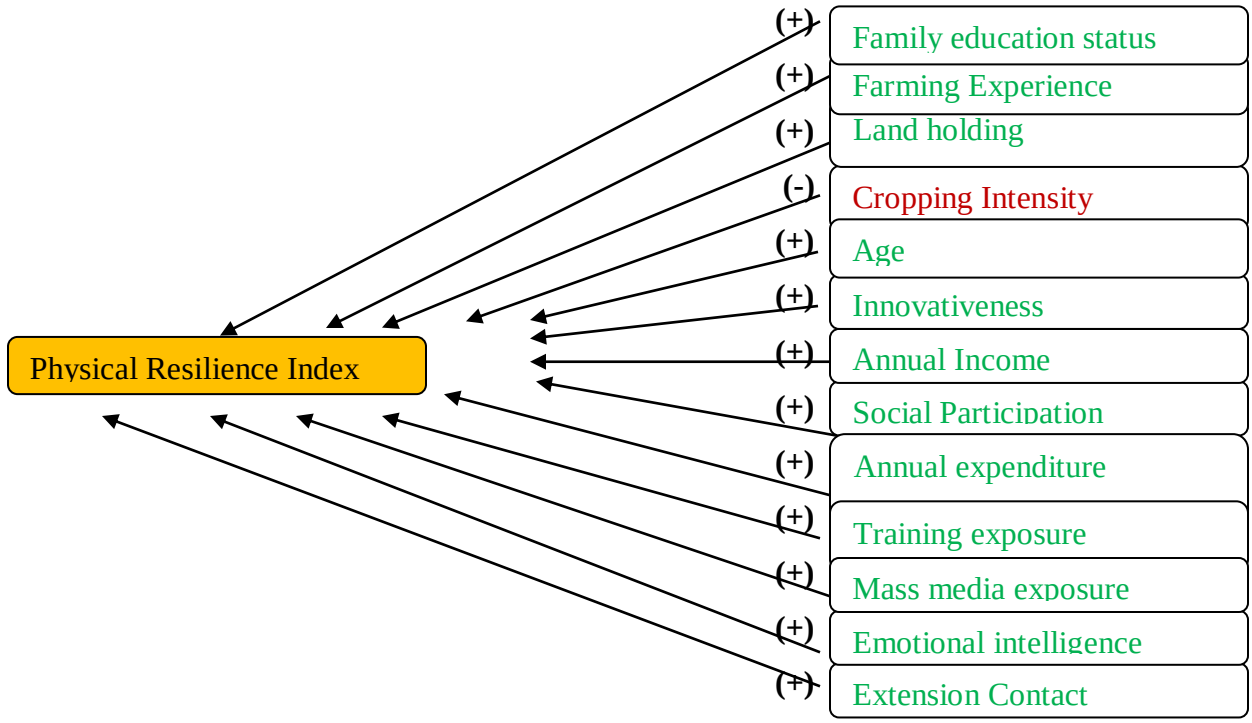


Fig.6.30: Diagrammatic representation of Coefficient of correlation(r) between Physical resilience index (Y_1) and 18 causal variables

Family education status and Physical resilience index

Family education status comprised of the formal educational attainment among the family members. A farm family with higher education status is always well to do in terms of knowledge which gives them enough power for new venture. A farm family with higher education status tends to more capacity and risk bearing ability for physical infrastructure development in their farm for their higher farm production as well as to avert disaster like situation. They maintain

long term land tenure system and try to develop drainage and irrigation system, road and farm electricity with their education and knowledge. An increase in Family education status affects the physical resilience of the farmers. Therefore, family education status is positively and significantly associated with the dependent variable, physical resilience index according to the perception of the agricultural producers.

Farming experience and Physical resilience index

The farming experience of the respondents reflects the age old experience about the production, protection and marketing practices of the agricultural produces. The farmer respondents with more farming experiences get extra knowledge and skills to manage the farm disasters. A farm family with more farming experiences tends to more capacity and risk bearing ability for physical infrastructure development in their farm for higher production as well as to minimize the impact of farm disaster. Well experienced farmers maintain standard land tenure system and try to develop drainage and irrigation system, farm road and electricity based on their experiences and knowledge. An increase in farming experience affects the physical resilience of the farmers. Therefore, farming experience is positively and significantly associated with the dependent variable, physical resilience index according to the perception of the farmer respondents.

Operational land holding, annual income and annual expenditure and Physical resilience index

The socio-economic variables operational land holding, annual income and annual expenditure are positively and significantly associated with the farmers' physical resilience index. The variables size of land holding, annual income and annual expenditure depicts the economic status of the family and enjoy the prestige in society. The economic resource, land holding is very much important to increase the farmers' disaster resilience level but sometimes it plays a contradictory role for ensuring sustainable agricultural production owing to its vulnerability to a wide range of farm disasters. Annual income and annual expenditure are completely inter-related with the farmers' physical resilience because if the income and expenditure are in imbalance then the entire family may face the problems of low level of physical resilience against various types farm disasters. The annual income and expenditure are undoubtedly the essential determinants influencing physical resilience of a famer family. In comparison to high-income households, the overall expenditures on various agri inputs are limited in low-income households. Annual

income is also found to be an essential factor in measuring physical resilience level at farmers. The low annual income is connected to poor physical resilience which leads to more vulnerable to disasters. The large size of operational land holding with high annual income and expenditure group can minimize the risk of farm disasters through developing farm drainage and irrigation system; road and farm electricity; and long term land tenure system. Therefore, the variables operational land holding, annual income and annual expenditure are positively and significantly associated with the farmers' physical resilience index.

Cropping intensity and Physical resilience index

Cropping intensity plays important role in enhancing the farmers' physical resilience. Logically increased gross crop area or cropping intensity tends to higher agricultural production leading to more income and physical resilience of farmers. It is observable that farmers having more cropping intensity are not concerned about the farm physical infrastructures such as farm drainage and irrigation system; road and farm electricity; and land development and long term land tenure system etc which can be adaptation strategies for enhancing farmers' physical resilience against various types of disasters. Therefore, a farmer with more cropping intensity is already familiar to farm physical infrastructure such as farm drainage and irrigation system; road and farm electricity; and land tenure system etc. As a result, such type of farmer shows lesser interest for the physical resilient development against farm disaster which they have already developed. Therefore, the variable cropping intensity is negatively and significantly associated with the dependent variable, physical resilience index.

Social participation, extension contact, mass media exposure, and training exposure and Physical resilience index

The extension-communication variables social participation, extension contact, mass media exposure, and training exposure are positively and significantly associated with the farmers' physical resilience index. These four extension-communication variables empowers the farming community to develop their insights through experiences and exposure. They play pivotal role to aware the farmer about the new agricultural technologies available in agricultural universities and research institutes, and Govt. schemes and subsidies for irrigation, drainage, farm electricity, farm road etc to be utilized in local situation .Training makes individual perfect to utilize the knowledge and skill in local situation. It empowers the farming community to make them able for application of technologies for agricultural and economic development. Social participation,

extension contact, mass media exposure and training are four determinants of information gathering, cosmopoliteness and venturesomeness. Due to these three possible outcomes the farmers are exposing themselves with their agricultural practices to the farm disaster resilience and vulnerability discourses. Though they have developed some logical mind set to cope the disasters but due to lack of physical infrastructure such as irrigation and drainage system; farm road and electricity and appropriate land tenure make them very much sensitive to various farm disasters. That is why the variables, social participation, extension contact, mass media exposure, and training exposure are positively and significantly associated with the farmers' physical resilience index.

Innovativeness and Physical resilience index

Innovativeness implies the adoption of innovation in any aspect. Innovativeness always helps the individual established themselves as innovative person in the society. In the present study, the farmer respondents with high level of innovativeness exposes themselves and their agriculture to the highest extent to farm disasters as their agriculture are mostly dependent on natural system and high external input oriented. Consequently, their agriculture is more sensitive to climate change vulnerability that may lead to disaster like situation such as flood, drought, frost, hailstorm, pest and disease etc. The farmer with high level of innovativeness can minimize the risk of farm disasters through developing innovative farm drainage and irrigation system; farm road and electricity connection; and long term land tenure system. That is why the variable innovativeness is positively and significantly associated with the dependent variable, farmers' physical resilience index according to the perception of farmer respondents.

Emotional intelligence and Physical resilience index

Emotional intelligence is undoubtedly the essential determinants influencing physical resilience of a farming family. Emotional intelligence comprising of self-awareness, emotion regulation, self-motivation, social awareness, social skills, emotional receptivity play pivotal role in increasing physical resilience against farm disasters. A socially aware and skilled; and self-motivated and emotionally controlled farmer can adjust in any kind of situation and develop farm drainage and irrigation system; road and farm electricity; and long term land tenure system etc earlier than the farmers with low level of emotional intelligence for averting the farm crisis situation such as flood, drought, hailstorm and pest and disease incidence etc. Therefore, the variable emotional intelligence is positively and significantly associated with the dependent variable, physical resilience index according to the perception of farmer respondents.

6.38 Stepwise Regression: Physical resilience index vs. 18 causal variables

Table 6.35 presents that the variables extension contact(X_{10}), training exposure(X_{12}), operational land holding(X_{05}) and economic motivation(X_{14}) are positively and significantly contributing towards characterizing the predicted variable, physical resilience index. It is discernable that the economic motivation has exerted highest direct effect in case of characterizing the predicted variable, physical resilience index.

Table6.35: Stepwise Regression: Physical resilience index vs. 18 causal variables

Sl. No.	Variables	Regression Coefficient B	S.E. of B	Beta	t-value	R^2
1	Extension contact(X_{10})	0.008	0.003	0.195	2.367*	0.334
2	Training exposure(X_{12})	0.004	0.001	0.310	4.635**	
3	Operational land holding(X_{05})	0.017	0.004	0.370	4.066**	
4	Economic motivation(X_{14})	0.004	0.001	0.371	4.941**	

** Significant at 1 % level, * Significant at 5% level

The R^2 value being 0.334, it is to infer that the eighteen predictor variables put together have explained 33.40% variation embedded with the predicted variable physical resilience index. Still 66.60% embedded with the predicted one remains unexplained. Thus, it would be suggested that inclusion of some more contextual variables possessing direct bearing on the physical resilience index could have increased the level of explicability.

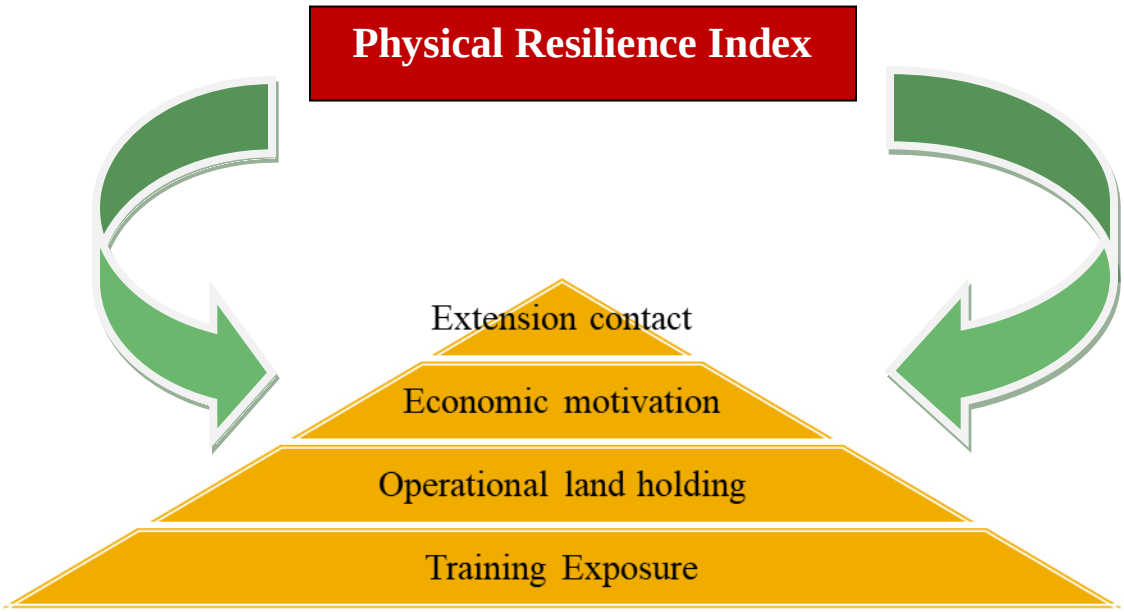


Fig.6.31: Diagrammatic representation of Stepwise Regression: Physical resilience index vs. 18 causal variables

Economic motivation and Physical resilience index

Economic motivation is a driving force of an individual to achieve the highest level of economic profit from an enterprise. The farmer respondents with high economic motivation always adopt the agricultural practices which have a high level of economic profit and technically feasible in local situation. Their thought process is always surrounding to enhance profitability from the farm using the appropriate farm technologies. The farmers with high level of economic motivation have quest for developing physical farm infrastructure such as drainage and irrigation system; farm road and electricity connection; and long term land tenure system etc which can be adaptation strategies for enhancing farmers' physical resilience to absorb and bounce back from the impact of farm disasters. Therefore, the variable, economic motivation is positively and significantly contributing towards characterizing the predicted variable, physical resilience index. Also, one unit change of the variable scientific orientation is delineating the 0.004unit change in the predicted variable. The variable scientific orientation is directly contributing 49.41% in case of characterizing the predicted variable, physical resilience index.

Extension contact and Physical resilience index

Extension contact empowers the farming community to develop their insights through experiences and exposure. It plays pivotal role to aware the farmer about the new agricultural technologies available in agricultural universities and research institutes to be utilized in local situation for bio-physical resource endowment and economic empowerment. It is an important determinant of information gathering, cosmopoliteness and venturesomeness. Due to these three possible outcomes the farmers are exposing themselves with their agricultural practices to the farm disaster resilience. Though they have developed some logical mind set to cope the disasters but due to lack of physical infrastructure such as irrigation and drainage system; farm road and electricity and appropriate land tenure make them very much sensitive to various farm disasters.

The farmer with higher level of extension contact prompt to development of farm physical infrastructure such as drainage system, irrigation system, farm road, electricity connection and standard land tenure system and such framers are more physically resilient for mitigating the impact of various types of farm disaster. Therefore, the variable, extension contact is positively and significantly contributing towards characterizing the predicted variable, physical resilience index. Also, one unit change of the variable extension contact is delineating the 0.008unit change in the predicted variable. The variable extension contact is directly contributing 19.50% in case

of characterizing the predicted variable, physical resilience index. Therefore, the variable extension contact is positively and significantly contributing towards characterizing the predicted variable, physical resilience index. Also, one unit change of the variable extension contact is delineating the 0.027 unit change in the predicted variable. The variable extension contact is directly contributing 41.40% in case of characterizing the predicted variable, physical resilience index.

Training exposure and Physical resilience index

The variable training exposure empowers the farming community to develop their insights through experiences and exposure. It plays pivotal role to aware the farmer about the new agricultural technologies, available Govt. agricultural schemes and subsidies to be utilized in local situation for bio-physical resource endowment and technical empowerment. Training makes individual perfect to utilize the knowledge and skill in local situation. It empowers the farming community to make them able for application of technologies for agricultural and economic development. Training is also considered as determinants of information gathering, cosmopoliteness and venturesomeness. Though they have developed some logical mind set to cope the disasters but due to lack of physical infrastructure and appropriate land tenure make them very much sensitive to various farm disasters. The farmer with higher level of training exposure prompt for development of farm physical infrastructure such as drainage system, irrigation system, farm road, electricity connection and standard land tenure system and such framers have more physical resilience for mitigating the impact of various types of farm disaster. Therefore, the variable, training exposure is positively and significantly contributing towards characterizing the predicted variable, physical resilience index. Also one unit change of the variable training exposure is delineating the 0.004unit change in the predicted variable. The variable extension contact is directly contributing 31.00% in case of characterizing the predicted variable, physical resilience index.

Operational land holding and Physical resilience index

Size of land holding depicts the economic status of the family and enjoys the prestige in society. The economic resource, land holding is very much important to increase the farmers' disaster resilience level but sometimes it plays a contradictory role for ensuring sustainable agricultural production owing to its vulnerability to a wide range of farm disasters. The farmer with large size of operational land holding tends for developing farm drainage and irrigation system; farm

road and electricity; and long term land tenure system where they get the opportunity of increasing physical resilience against various types of disaster. Therefore, the variable, size of land holding is positively and significantly contributing towards characterizing the predicted variable, physical resilience index. Also, one unit change of the variable operational land holding is delineating the 0.017unit change in the predicted variable. The variable, size of land holding is directly contributing 37.00% in case of characterizing the predicted variable, physical resilience index.

6.3.9 Coefficient of correlation(r) between Farmer resilience index (Y_5) and 18 causal variables

Table 6.36 indicates the Pearson's coefficient of correlation among the dependent variable i.e. Farmer resilience index and 18 causal variables. The result shows that the variables namely family education status**(**X_2**)**, operational land holding**(**X_5**)**, annual income**(**X_7**)**, annual expenditure**(**X_8**)**, social participation**(**X_9**)**, extension contact**(**X_{10}**)**, mass media exposure**(**X_{11}**)**, training exposure**(**X_{12}**)**, innovativeness**(**X_{13}**)**, economic motivation**(**X_{14}**)**, scientific orientation**(**X_{15}**)**, management orientation**(**X_{16}**)**, risk bearing ability**(**X_{17}**)** and emotional intelligence**(**X_{18} **)** are positively and significantly associated with the dependent variable, physical resilience index(Y_4).On the other hand, the variable cropping intensity**(**X_6**)** and family size**(**X_4**)** are negatively and significantly associated with the dependent variable, Farmer resilience index (Y_5).

Table 6.36: Coefficient of correlation(r) between Farmer resilience index (Y) and 18 causal variables

Sl. No.	Variable	Coefficient of correlation(r)
Independent Variable		
Socio-personal variable		
1.	Age **(**X_1**)**	-0.052
2.	Family education status **(**X_2**)**	0.233**
3.	Farming experience**(**X_3**)**	-0.130
4.	Family size**(**X_4**)**	-0.140*
Socio-economic variable		
5.	Operational land holding**(**X_5**)**	0.468**
6.	Cropping intensity**(**X_6**)**	-0.355**
7.	Annual income**(**X_7**)**	0.542**
8.	Annual expenditure**(**X_8**)**	0.554**
Extension-communication variable		
9.	Social participation**(**X_9**)**	0.314**

10.	Extension contact(X_{10})	0.495**
11.	Mass media exposure(X_{11})	0.519**
12.	Training exposure(X_{12})	0.372**
Socio-psychological variable		
13.	Innovativeness(X_{13})	0.156*
14.	Economic motivation(X_{14})	0.486**
15.	Scientific orientation(X_{15})	0.503**
16.	Management orientation(X_{16})	0.510**
17.	Risk bearing ability(X_{17})	0.508**
18.	Emotional intelligence(X_{18})	0.399**

** Significant at 1 % level, * Significant at 5% level

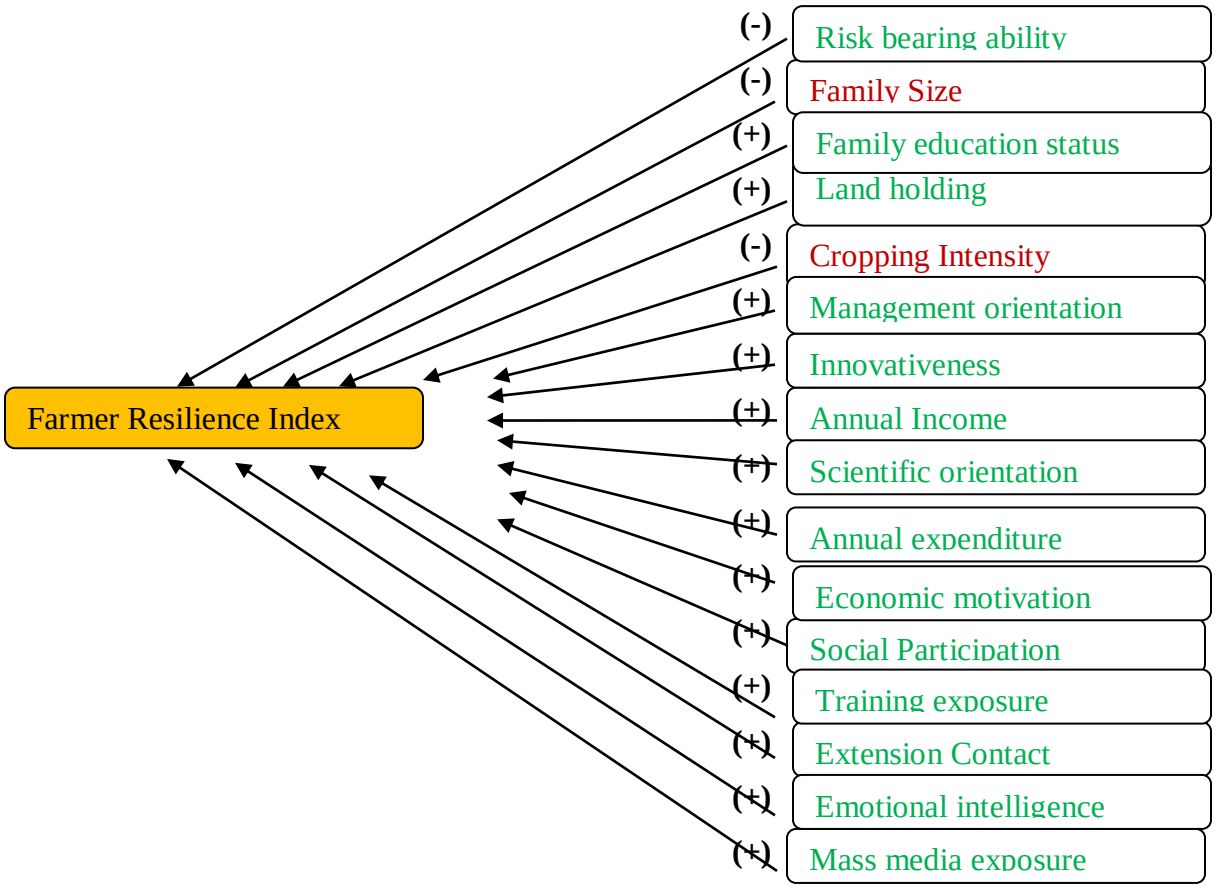


Fig. 6.32: Diagrammatic representation of Coefficient of correlation(r) between Farmer resilience index (Y) and 18 causal variables

Family education status and Farmer resilience index

Family education status comprised of the formal educational attainment among the family members. A farm family with higher education status is always well to do in terms of knowledge which gives them enough power for new venture. A farm family with higher education status

tends to more capacity and risk bearing ability leading to resilient development in their farm for their higher farm production as well as to avert disaster like situation. Farmer with higher education status facilitates gaining knowledge and application of disaster mitigation farm technologies. An increase in family education status affects the economic, social, technical and physical resilience of the farmers. Therefore, family education status is positively and significantly associated with the dependent variable, farmer resilience index according to the perception of the farmer respondents

Family size and Farmer resilience index

The family size is representation of the total number of individuals present in a particular family. Sometimes the farmers' disaster resilience depends on the size of family because the large size family, the food and other resource requirement are always more compare to small family. Family size is a significant determinant of household food security and farmers' disaster resilience as far as sustainable agricultural production is concerned. A large family size puts an extra burden of more expenditure on various family requirements such as health, education, food, shelter, clothes and other ceremonial social function etc and more likely to experience poor disaster resilience in contrast to households with a small family size. Moreover, expenditure on adoption of farm disaster mitigation technologies and practices comparatively higher than farmers' production practices. Members of large families tend to compete for the limited resources available in the household. Due to the farm disaster discourses the production of food is also limited in nature and the food system has a limited capacity to feed the large number of family members which lead to poor resilience. Consequently, the variable family size is negatively and significantly associated with the dependent variable, farmer resilience index

Operational land holding, annual income and annual expenditure and Farmer resilience index

The socio-economic variables operational land holding, annual income and annual expenditure are positively and significantly associated with the farmer resilience index. The variables size of land holding, annual income and annual expenditure depicts the economic status of the family and enjoy the prestige in society. The economic resource, land holding is very much important to increase the farmers' disaster resilience level but sometimes it plays a contradictory role for ensuring sustainable agricultural production owing to its vulnerability to a wide range of farm disasters. Annual income and annual expenditure are completely inter-related with the farmers'

resilience because if the income and expenditure are in imbalance then the entire family may face the problems of low level of farmer resilience against various types farm disasters. The annual income and expenditure are undoubtedly the essential determinants influencing resilience of a famer family. In comparison to high-income households, the overall expenditures on various agri inputs are limited in low-income households. Annual income is also found to be an essential factor in measuring farmer resilience level against various types of disasters. The low annual income is connected to poor resilience level which leads to more vulnerable to disasters. The large size of operational land holding with high annual income and expenditure group can minimize the risk of farm. Therefore, the variables operational land holding, annual income and annual expenditure are positively and significantly associated with the farmer resilience index.

Social participation, extension contact, mass media exposure, and training exposure and Farmer resilience index

The extension-communication variables social participation, extension contact, mass media exposure, and training exposure are positively and significantly associated with the farmer resilience index. These four extension-communication variables empowers the farming community to develop their insights through experiences and exposure .They play pivotal role to aware the farmer about the new agricultural technologies available in agricultural universities and research institutes, and Govt. schemes and subsidies for agricultural development to be utilized in local situation .Training makes individual perfect to utilize the knowledge and skill in local situation. It empowers the farming community to make them able for application of technologies for agricultural and economic development. Social participation, extension contact, mass media exposure and training are four determinants of information gathering, cosmopoliteness and venturesomeness. Due to these three possible outcomes the farmers are exposing themselves with their agricultural practices to the farm disaster resilience and vulnerability discourses. Though they have developed some logical mind set to cope the disasters but due to lack of physical infrastructure such as irrigation and drainage system; farm road and electricity and appropriate land tenure make them very much sensitive to various farm disasters. That is why the variables, social participation, extension contact, mass media exposure, and training exposure are positively and significantly associated with the farmer resilience index.

Innovativeness and Farmer resilience index

Innovativeness implies the adoption of innovation in any aspect. Innovativeness always helps the individual established themselves as innovative person in the society. In the present study, the farmer respondents with high level of innovativeness exposes themselves and their agriculture to the highest extent to farm disasters as their agriculture are mostly dependent on natural system and high external input oriented. Consequently their agriculture is more sensitive to climate change vulnerability that may lead to disaster like situation such as flood, drought, frost, hailstorm, pest and disease etc. The farmer with high level of innovativeness can minimize the risk of farm disasters through developing innovative disaster mitigating farm practices and physical farm infrastructure. That is why the variable innovativeness is positively and significantly associated with the dependent variable, farmer resilience index according to the perception of farmer respondents

Economic motivation and Farmer resilience index

Economic motivation is a driving force of an individual to achieve the highest level of economic profit from an enterprise. The farmer respondents with high economic motivation always adopt the agricultural practices which have a high level of economic profit and technically feasible in local situation. Their thought process is always surrounding to enhance profitability from the farm using the appropriate farm technologies. This will lead to increasing their resilience to absorb the shock and bounce back from the impact of farm disaster. That is why the variable economic motivation is positively and significantly associated with the dependent variable, farmer resilience index according to the perception of farmer respondents.

Scientific orientation and Farmer resilience index

Scientific orientation always is impacting upon the logical creation of mindset towards any innovative practices. The high level of scientific orientation among the farmer respondents develops the acumen for logical adoption of agricultural innovation. The technological advancement in agriculture always banks upon economic profitability with the help of high external inputs involvement. The farmers with high scientific orientation go along with the advocated scientific technologies for profit maximization and increase their resilience towards various types of farm disasters. Therefore, the variable scientific orientation is positively and significantly associated with the dependent variable, farmer resilience index according to the perception of farmer respondents.

Management orientation and Farmer resilience index

Management orientation is the degree to which a farmer is oriented towards scientific farm management comprising planning, production and marketing function of his or her farm. The farmer respondents with proper planning in various farm operations from land preparation to marketing of farm produce and unexpected farm disasters realize sustainable production and income. Moreover, more management oriented farmers prepare a contingency plan, adopt farm disaster mitigating technologies and uses weather data and flood/drought/storm disaster warning etc. for averting the risk of any kind of farm disaster. This will enhance their resilience level against impact of farm disasters. Therefore, the variable management orientation is positively and significantly associated with the dependent variable, farmer resilience index according to the perception of farmer respondents.

Risk bearing ability and Farmer resilience index

Risk bearing ability makes an individual more venturesome and whimsical. The farmer respondents with high risk bearing ability takes much more risk applying agricultural technology for maximizing the production and profit in any unpredictable bio physical situations which lead their resilience development. Those farmers are taking more risk to get more economic benefit by applying farm disaster mitigation technologies, subsequently develop their resilience level against various farm disasters. Consequently, those risk taker farmers are more resilient to disasters risk in agriculture. That is why the variable risk bearing ability is positively and significantly associated with the dependent variable, farmer index according to the perception of farmer respondents.

Emotional intelligence and Farmer resilience index

Emotional intelligence is undoubtedly the essential determinants influencing resilience level of a farming family. Emotional intelligence comprising of self awareness ,emotion regulation ,self motivation ,social awareness ,social skills ,emotional receptivity play pivotal role in increasing physical resilience against farm disasters. A socially aware and skilled; and self motivated and emotionally controlled farmer can adjust in any kind of situation and develop resilience level earlier than the farmers with low level of emotional intelligence for averting the farm crisis situation such as flood, drought, hailstorm and pest and disease incidence etc. Therefore, the variable emotional intelligence is positively and significantly associated with the dependent variable, farmer resilience index according to the perception of farmer respondents.

Cropping intensity and Farmer resilience index

Cropping intensity plays important role in enhancing the farmers' resilience level. Logically increased cropping intensity tends to higher agricultural production leading to more income and resilience of farmers against farm disasters. It is observable that farmers having more cropping intensity are not concerned about the knowledge of flood and drought resistant varieties, early maturing crop varieties, intercropping, relay cropping, integrated farming system, unconventional production practices, modern plant protection technologies, daily weather data, flood/drought/storm disaster warning etc which can be adaptation strategies for enhancing farmers' resilience level against various types of disasters. It may be, a farmer with more cropping intensity is already familiar with flood and drought resistant varieties, early maturing crop varieties, intercropping, relay cropping, integrated farming system, unconventional production practices, modern plant protection technologies, daily weather data, flood/drought/storm disaster warning etc. and Govt. agri cultural development schemes and subsidies As a result, such type of farmer shows lesser interest for the resilient development against farm disaster which they have already developed. Therefore, the variable, cropping intensity is negatively and significantly associated with the predicted variable, farmer resilience index.

6.3.10 Stepwise Regression Farmer resilience index vs. 18 causal variables

Table 6.37 reflects that the variables Annual expenditure(X_{08}), scientific orientation(X_{15}) and extension contact(X_{10}) are positively and significantly contributing towards characterizing the predicted variable, farmer resilience index. It is discernable that the scientific orientation has exerted highest direct effect in case of characterizing the predicted variable, farmer resilience index.

Table6.37: Stepwise Regression Farmer resilience index vs. 18 causal variables

Sl. No.	Variables	Regression Coefficient B	S.E. of B	Beta	t-value	R^2
1	Annual expenditure(X_{08})	0.009	0.004	0.190	2.311*	0.422
2	Scientific orientation(X_{15})	0.002	0.000	0.341	5.360**	
3	Extension contact(X_{10})	0.009	0.002	0.293	4.018**	

** Significant at 1 % level, * Significant at 5% level

The R^2 value being 0.422, it is to infer that the eighteen predictor variables put together have explained 42.20% variation embedded with the predicted variable farmer resilience index. Still 57.80% embedded with the predicted one remains unexplained. Thus it would be suggested that inclusion of some more contextual variables possessing direct bearing on the farmer resilience index could have increased the level of explicability.

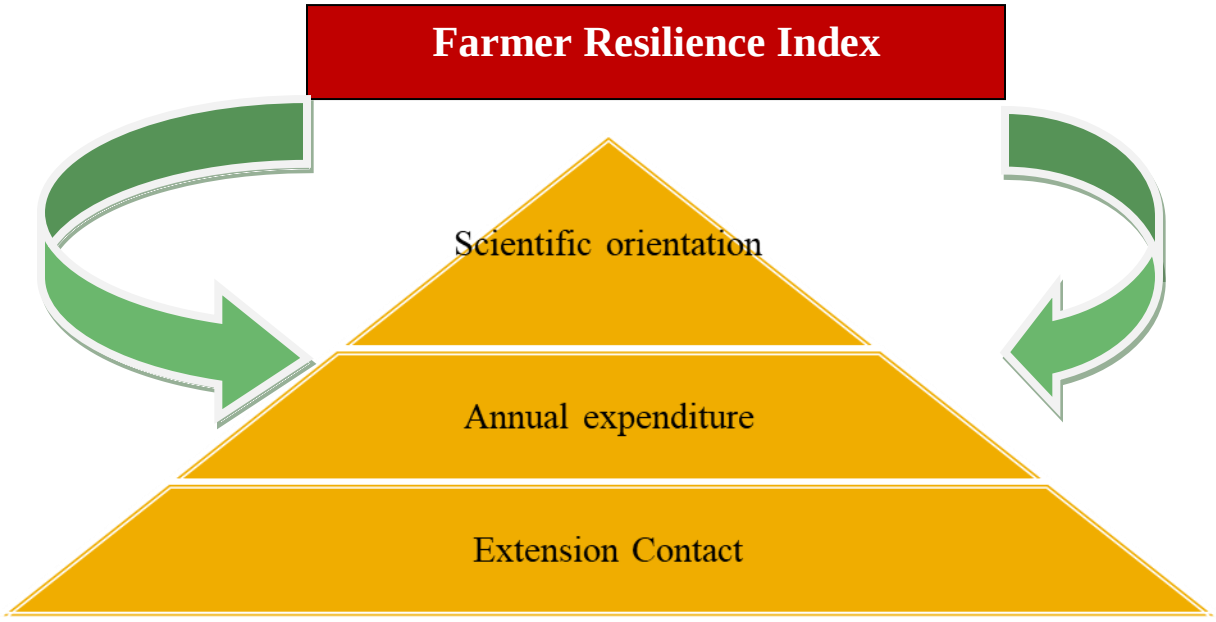


Fig.6.33: Diagrammatic representation of Stepwise Regression: Farmer resilience index vs. 18 causal variables

Annual expenditure and Farmer resilience index

The socio-economic variable annual expenditure depicts the economic status of the family and enjoys the prestige in society. Annual income and annual expenditure are completely inter-related with the farmers' technical resilience because if the income and expenditure are in imbalance then the entire family may face the problems of low level of resilience against various types naturally induced farm hazards. In comparison to high-income households, the overall expenditures on various agri inputs are limited in low-income households. Logically high income tends to high expenditure. The high annual income and expenditure group can minimize the risk of farm disasters through adopting flood and drought resistant varieties, early maturing crop varieties, intercropping, relay cropping, integrated farming system, unconventional production practices, modern plant protection technologies and accessing daily weather data, flood/drought/storm disaster warning etc. They also go for agricultural finance, insurance,

developmental schemes, subsidies and farm infrastructure such as irrigation, drainage system development easily which can be adaptation strategies for enhancing farmers' disaster resilience.

Expenditure on adoption of farm disaster mitigation technologies and practices comparatively more than farmers' production practices. Therefore, the variable, annual expenditure is positively and significantly contributing towards characterizing the predicted variable, farmer resilience index. Also one unit change of the variable annual expenditure is delineating the 0.009 unit change in the predicted variable. The variable annual expenditure is directly contributing 19.00% in case of characterizing the predicted variable, farmer resilience index.

Scientific orientation and Farmer resilience index

Scientific orientation always is impacting upon the logical creation of mindset towards any innovative practices. The high level of scientific orientation among the farmer respondents develops the acumen for logical adoption of agricultural innovation. The technological advancement in agriculture always banks upon economic profitability with the help of high external inputs involvement. The farmers with high scientific orientation go along with the advocated scientific technologies for profit maximization and increase their resilience against various types of agricultural disasters. As a result, those farmers do not face much difficulty in managing the farm related disasters. As scientific orientation increases, the farmers tend to gain the knowledge of flood and drought resistant varieties, early maturing crop varieties, intercropping, relay cropping, integrated farming system, unconventional production practices, modern plant protection technologies , daily weather data, flood/drought/storm disaster warning etc, agricultural finance, insurance, community basic services and social safety net, farm infrastructure which can be adaptation strategies for enhancing farmers' disaster resilience. Therefore, the variable, scientific orientation is positively and significantly contributing towards characterizing the predicted variable, farmer resilience index. Also, one unit change of the variable scientific orientation is delineating the 0.002 unit change in the predicted variable. The variable scientific orientation is directly contributing 59.40% in case of characterizing the predicted variable, farmer resilience index.

Extension contact and Farmer resilience index

Extension contact empowers the farming community to develop their insights through experiences and exposure. It plays pivotal role to aware the farmer about the new agricultural technologies; farm disaster mitigation technologies; agricultural development schemes and

subsidies; agricultural insurance schemes; available community basic services; social safety nets; weather report; disaster warning etc and other physical infrastructure meant for development of farming community. It is an important determinant of information gathering, cosmopoliteness and venturesomeness. Due to these three possible outcomes the farmers are exposing themselves with their agricultural practices to the farm disaster resilience. Though they have developed some logical mind set to cope the disasters but due to lack of available farm disaster mitigation technologies; agricultural development schemes and subsidies; agricultural insurance schemes; available community basic services; social safety nets; weather report; disaster warning etc and farm infrastructure such as irrigation and drainage system; farm road and electricity and appropriate land tenure make them very much sensitive to various farm disasters. The farmer with higher level of extension contact is more resilient towards the impact of various types of farm disaster. Therefore, the variable, extension contact is positively and significantly contributing towards characterizing the predicted variable, farmer resilience index. Also one unit change of the variable extension contact is delineating the 0.008unit change in the predicted variable. The variable extension contact is directly contributing 19.50% in case of characterizing the predicted variable, physical resilience index. Therefore, the variable extension contact is positively and significantly contributing towards characterizing the predicted variable, physical resilience index. Also one unit change of the variable extension contact is delineating the 0.009unit change in the predicted variable. The variable extension contact is directly contributing 29.30% in case of characterizing the predicted variable, farmer resilience index.

6.3.11 Analysis of Variance (ANOVA) in relation to farmer resilience index

ANOVA test was performed to test the significance difference among the Farmer Resilience Index mean of different villages. It was found that calculated F value at (7,192) degree of freedom and 5% level of significance is 0.067 which is less than the critical value limit. So it can be concluded that there is no significant difference among the villages with respect to Farmer Resilience Index (Table 6.38)

Table 6.38: Analysis of variance for farmer resilience index of villages

Source of variations	SS	DF	MS	F
Villages	.001	7	7.879	.067
Error	.227	192	.001	

6.3.12: Factor analysis of the variables by principal component analysis in relation to farmer resilience index

Table 6.39 presents the factor analysis of the variables by principal component analysis in relation to farmer disaster resilience. Factor analysis is a very useful and popular method of multivariate research technique. Factor analysis seeks to resolve a large set of measured variables in terms of relatively few categories, known as factors. The present table depicted the factor loadings to show the variable in close interdependence, communality to show how much of each variable is accounted for by the underlying factors taken together. The table shows that the four factors among the variables are isolated in the present study.

Table 6.39: Factor analysis of the variables by principal component analysis in relation to farmer resilience index

Factor	Variable	Factor loading	Eigen value	% of variance	Cumulative % of variance	Rename
I	Operational land holding(X_5)	0.838	6.470	35.946	35.946	Psycho-economic competency
	Cropping intensity(X_6)	0.637				
	Annual income(X_7)	0.870				
	Annual expenditure(X_8)	0.848				
	Extension contact(X_{10})	0.684				
	Mass media exposure(X_{11})	0.776				
	Economic motivation (X_{14})	0.795				
	Scientific orientation (X_{15})	0.820				
	Management orientation(X_{16})	0.853				
	Risk bearing ability(X_{17})	0.846				
	Emotional intelligence(X_{18})	0.480				
II	Age(X_1)	0.875	3.253	18.072	54.018	Personal expertise
	Farming experience(X_3)	0.895				
	Family size(X_4)	0.529				
III	Social participation(X_9)	0.473	2.110	11.721	65.739	Capacity building
	Training exposure(X_{12})	0.707				
	Innovativeness(X_{13})	0.497				
IV	Family education(X_2)	0.698	1.286	7.142	72.881	Educational exposure

The Factor I includes the following variables operational land holding, cropping intensity, annual income, annual expenditure, extension contact, mass media exposure, economic motivation,

scientific orientation, and management orientation, risk bearing ability and emotional intelligence and causes 35.94 percent of variation within the study. Thus, this factor presented unquestionable domination over the others and can be renamed **Psycho-economic competency** factor. Factor II includes the variables age, farming experience and family size and hence could be clubbed in to a single factor and be renamed as **Personal expertise**. Factor III includes the variables social participation, training exposure and innovativeness and hence could be clubbed in to a single factor and be renamed as **Capacity building**. Factor IV includes the only one variable, family education and can be renamed as **Educational exposure**.

6.3.13 Artificial Neural Network analysis of Farmer Resilience Index with 18 predictor variables

A Multilayer Perceptron Neural Network (MPN) (Popescu et al., 2009) model has been formed, taking the dependent variable in the output layer and the input layer consisted of the predictors estimated in the stepwise regression process. The blue lines through the hidden layers within the output and input layers depict the interrelationships among them. Each unit is connected to all units of the next level and each unit receives input from all units of the previous level. Each connection has a specific weight and this weight illustrates the effect of the unit on the response of the unit to the next level. The output of a multilayer perceptron depends on the input and the connecting strength of the units. When information is sent to the multilayer perceptron by generating neurons at the input level, this information is processed layer by layer until the output layer is finally activated. Given adequate concealed units and sufficient data, it has been shown that multilayer preceptors can predict virtually any function for desired accuracy. However, consideration of overall performance of all predictor variables throughout the neural network is important to determine masking effects or direct and/or indirect influence of other variables, which finally determines the contribution of all of these predictors towards the predicted variables. This is vividly depicted in the normalized importance graph, where X_3 has survived to depict the maximum influence over the dependent variables. The sequential arrangement of other X variables can be showed as X_3> X_8> X_{11}> X_{10}> X_7> X_{15}> X_{16}> X_{14}> X_{12}> X_4> X_6> X_9> X_1> X_{13}> X_{17}> X_5> X_2> X_{18} which shows that X_3 and X_8 has better influence on the dependent variables as well as masking effects on these X variables, presumably due these X's contribution to those Y variables. This establishes a wholesome scenario of all predictors, not only influencing the dependent variable, but also influencing each other over that effect on dependent variables (Figure 6.34 and 6.35).

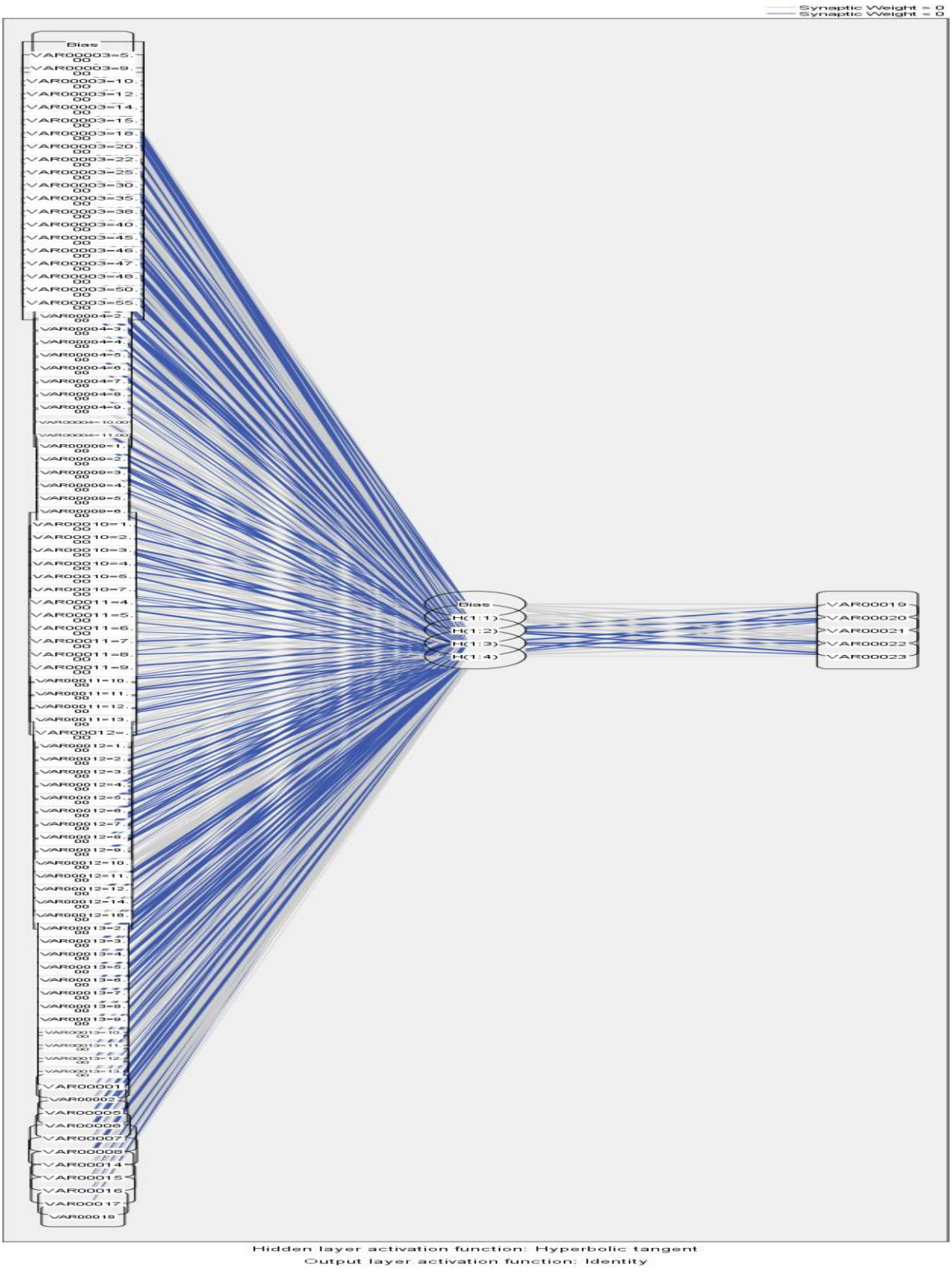


Fig.6.34 Artificial Neural Network of predictor variables(X_1-X_{18}) with respect to predicted variables (Y_1-Y_5)

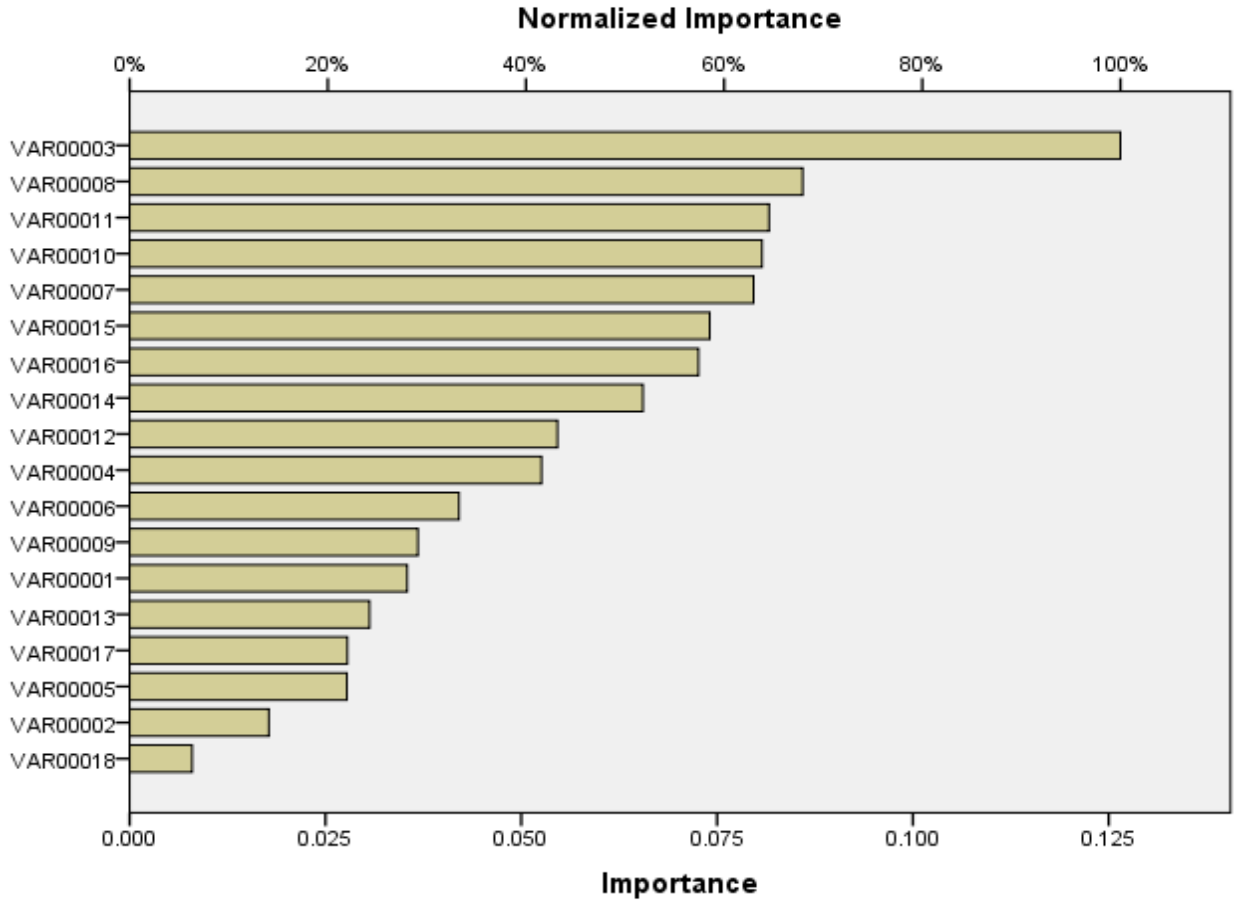


Fig.6.35: Normalized importance diagram of predicted variables with respect to 18 predictor variables

[Age(X_1), Family education(X_2), Farming experience(X_3), Family size(X_4), Operational land holding(X_5), Cropping intensity(X_6), Annual income(X_7), Annual expenditure(X_8), Social participation(X_9), Extension contact(X_{10}), Mass media exposure(X_{11}), Training exposure(X_{12}), Innovativeness(X_{13}), Economic motivation(X_{14}), Scientific orientation(X_{15}), Management orientation(X_{16}), Risk bearing ability(X_{17}), Emotional intelligence(X_{18})]

6.4 Agricultural extension needs of Farmer for disaster resilience

Present study examines differential agricultural extension needs of the farmers for disaster resilience in the thematic areas of agricultural inputs, agricultural finance, agricultural production, post harvest management, marketing, livelihood diversification, capacity building or training, demonstrations under three dimensions such as up to date information; advisory service/training and demonstration, and mitigation strategy. To assess the farmers' extension needs on different thematic areas, respondent farmers are asked to rank as per their preferences and their responses were taken through interview schedule. The Garrette Ranking Technique is used to rank the preference on different thematic areas of agricultural extension needs under

different associated dimension for mitigating the farm disasters as perceived by the farmer respondents.

6.4.1.1 Agricultural extension needs on the thematic area of agricultural inputs under up to date Information dimension

Table 6.40 presents the farmers' preferences of agricultural extension needs on the thematic area of agricultural inputs under up to date Information dimension to mitigate agricultural disasters and ensuring food security. The result shows that the farmers mostly prefer the information namely flood and drought resistant varieties, and disease and pest resistant varieties with highest average Garret score of 54.26 to develop strategic flood/drought/pest and disease adaptation and mitigation plan for minimizing the impact of farm disasters. The second most preferred information is HYVs and hybrids seeds with second highest average Garret score of 53.79 for taking the appropriate farm production planning decision to increase resilience capacity against farm disasters. The third preferred information is prices and subsidy schemes of Govt. for machineries, equipment and implements with average Garret score of 52.91 for easing the decision making process for procuring different farm machineries, equipments and implements for effective farm operation to avert the negative impact of farm disasters .The other preferred information extension needs to mitigate the impact of farm disasters according to farmers' priority are techniques and method of seed production at own farm; crop contingency plan; crop-wise recommended dose of fertilizers; good quality and certified seeds of improved varieties; service/subsidies/Schemes in Irrigation sector; sources and services related to plant protection; different pesticides and their usages; different methods of fertilizer application (basal application, topdressing, etc.); labour saving technologies; water harvesting techniques; water efficient crops (less water requirement); equipment and implements required for different agricultural operations and sources and availability of fertilizers.

Table 6.40: Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of agricultural inputs under up to date Information dimension

Dimension	Thematic area	Extension need items	Garrett Score	Rank
A. Up to date Information	**I. Agricultural Inputs**	1.Information on flood and drought resistant varieties, and disease and pest resistant varieties	54.26	**I**
		2. Information on HYVs, hybrids seeds	53.79	**II**

		3. Information on good quality and certified seeds of improved varieties	50.39	**VII**
		4.Information on techniques and method of seed production at own farm	51.51	**IV**
		5.Information related to crop- wise recommended dose of fertilizers	50.66	**VI**
		6. Information on sources and availability of fertilizers	44.41	**XVI**
		7. Information on different methods of fertilizer application (basal application, topdressing, etc.)	48.90	**XI**
		8.Information on water efficient crops (less water requirement)	48.05	**XIV**
		9.Iinformation on water harvesting techniques	48.14	**XIII**
		10.Information on related to service/subsidies/Schemes in Irrigation sector	49.63	**VIII**
		11. Information on sources and services related to plant protection	49.61	**IX**
		12. Information on related to different pesticides and their usages	49.34	**X**
		13. Information on equipment and implements required for different agricultural operations	47.85	**XV**
		14. Information on prices and subsidy schemes of Govt. for machineries, equipment and implements	52.91	**III**
		15.Information on crop contingency plan	50.98	**V**
		16.Information on labour saving technologies	48.85	**XII**

6.4.1.2 Agricultural extension needs on the thematic area of agricultural finance under up to date Information dimension

Table 6.41 presents the farmers' preferences of agricultural extension needs on the thematic area of agricultural finance under up to date Information dimension to mitigate agricultural disasters and ensuring food security. The result indicates that the farmers mostly prefer the information namely amount of subsidies given by Govt. for produce and different farm inputs like seeds, fertilizers, irrigation and farm tools and machineries etc with highest average Garret score of 54.625 to develop strategic adaptation and mitigation plan for minimizing the impact of farm disasters. The second most preferred information is Pradhan Mantri Fasal Bima Yojana (PMFBY) with second highest average Garret score of 52.76 for taking the appropriate farm

production planning decision to increase resilience capacity against farm disasters. The third preferred information is agencies providing insurance services in agricultural sector with average Garret score of 50.505 for easing the decision making process for crop insurance to avert the negative impact of farm disasters. The other preferred information extension needs to mitigate the impact of farm disasters according to farmers' priority are agricultural loans ; financial assistance for cultivation of specific crops (like medicinal plants, commercial crops, horticultural, floricultural crops etc.) and subsidies given by the Govt. for agricultural sector.

Table 6.41: Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of agricultural finance under up to date Information dimension

Dimension	Thematic area	Extension need items	Garrett Score	Rank
A. Up to date Information	**II. Agricultural Finance**	1.Information related to agricultural loans	47.975	**IV**
		2. Information on financial assistance for cultivation of specific crops (like medicinal plants, commercial crops, horticultural, floricultural crops etc.)	47.15	**V**
		3.Information services on subsidies given by the Govt. for agricultural sector	46.985	**VI**
		4.Information on amount of subsidies given by Govt. for produce and different farm inputs like seeds,fertilizers,irrigation and farm tools and machineries etc	54.625	**I**
		5.Information on agencies providing insurance services in agricultural sector	50.505	**III**
		6.Information on Pradhan Mantri Fasal Bima Yojana (PMFBY)	52.76	**II**

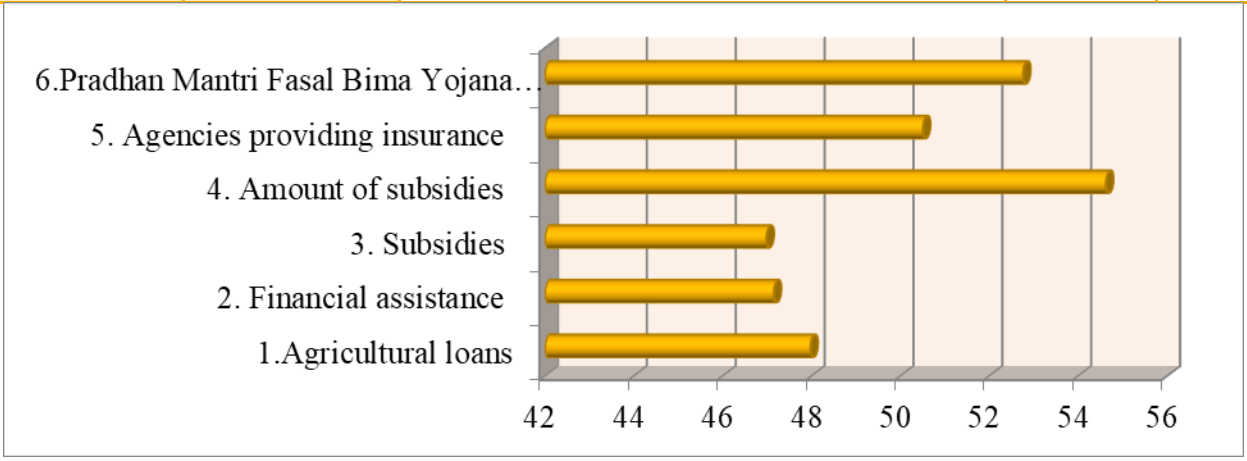


Fig.6.36: Diagrammatic representation of Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of agricultural finance under up to date Information dimension

6.4.1.3 Agricultural extension needs on the thematic area of agricultural production under up to date Information dimension

Table 6.42 shows the farmers' preferences of agricultural extension needs on the thematic area of agricultural production under up to date Information dimension for agricultural disasters management and ensuring food security. The result indicates that the farmers mostly prefer the information namely preparedness against natural calamities with highest average Garret score of 54.19 to develop strategic adaptation plan for minimizing the impact of farm disasters. The second most preferred information is choosing the pesticide according to the pest incidence)with second highest average Garret score of 51.40 for taking the appropriate steps for managing the crop pest and diseases disaster. The third preferred information is soil testing service with average Garret score of 50.553 for easing the decision making process for crop management to minimize negative impact of farm disasters .The other preferred information extension needs to mitigate the impact of farm disasters according to farmers' priority are current updates of weather; universal soil health card scheme; integrated nutrient management; weather forecasting, integrated pest management(IPM) and latest technologies/ equipment for harvesting.

Table 6.42: Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of agricultural production under up to date Information dimension

Dimension	Thematic area	Extension need items	Garrett Score	Rank
A. Up to date Information	**III. Agricultural production**	1. Information on soil testing service	50.53	**III**
		2.Information on the universal soil health card scheme	50.24	**V**
		3.Information on current updates of weather	50.275	**IV**
		4.Information on weather forecasting	49.16	**VII**
		5.Information on preparedness against natural calamities	54.19	**I**
		6.Information on integrated nutrient management	50.075	**VI**
		7.Information or advisory services for choosing the pesticide according to the pest incidence	51.4	**II**
		8. Information and knowledge on IPM	49.045	**VIII**
		9. Information on latest technologies/ equipment for harvesting	46.40	**IX**

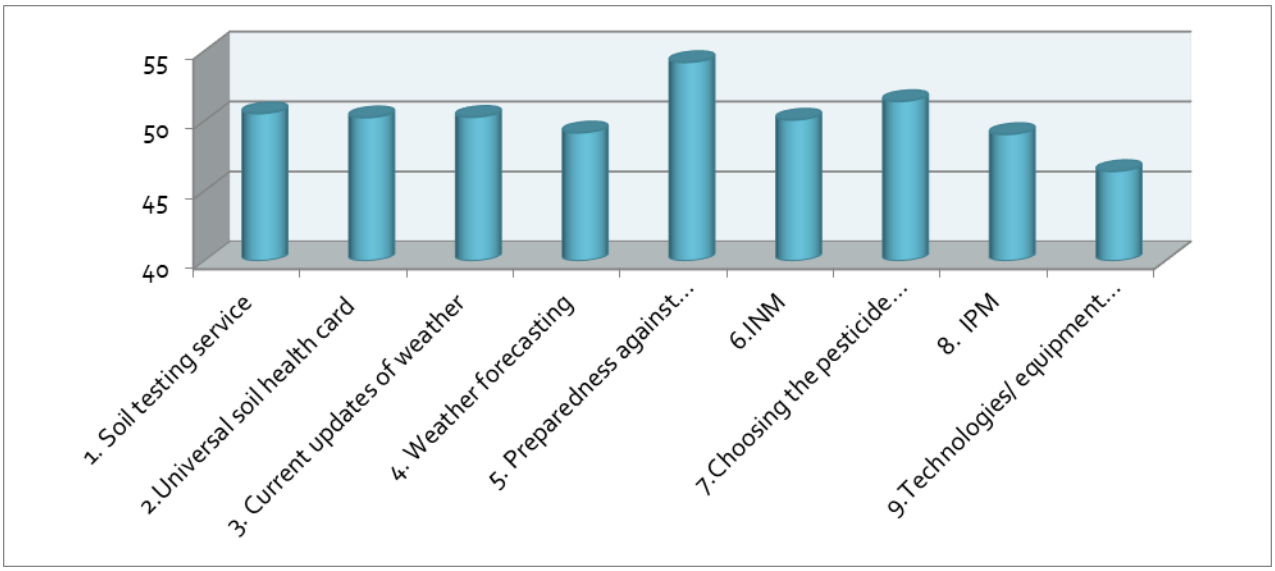


Fig.6.37: Diagrammatic representation of Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of agricultural production under up to date Information dimension

6.4.1.4 Agricultural extension needs on the thematic area of Post harvest management under up to date Information dimension

Table 6.43 presents the farmers' preferences of agricultural extension needs on the thematic area of Post harvest management under up to date Information dimension for increasing agricultural disasters resilience and ensuring food security. The result indicates that the farmers mostly prefer the information namely subsidy or credit schemes for storing with highest average Garret score of 56.60 to develop strategic mitigation plan for minimizing the impact of farm disasters. The second most preferred information is latest machines and technologies for grading with second highest average Garret score of 53.60 for taking the appropriate farm production marketing decision to enhance resilience capacity against farm disasters. The third preferred information is latest processing technologies for farm production with average Garret score of 50.10 for easing the decision making process for marketing of farm production to avert the negative impact of farm disasters. The other preferred information extension needs to mitigate the impact of farm disasters according to farmers' priority are value addition of own farm produce and contact details of nearby storage facilities.

Table 6.43: Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of Post harvest management under up to date Information dimension

Dimension	Thematic area	Extension need items	Garrett Score	Rank
A.Up to date Information	**IV.Post harvest management**	1. Information on latest processing technologies for farm production	50.10	**III**
		2. Information on value addition of your farm produce	44.95	**IV**
		3. Information on contact details of nearby storage facilities	42.45	**V**
		4. Information on subsidy or credit schemes for storing	56.60	**I**
		5.Information on latest machines and technologies for grading	53.60	**II**

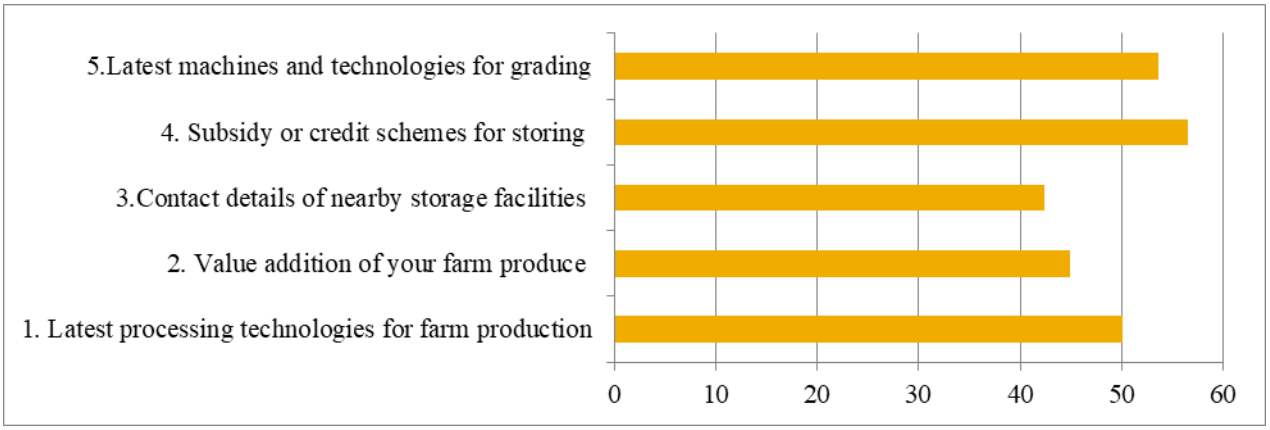


Fig.6.38: Diagrammatic representation of Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of Post harvest management under up to date Information dimension

6.4.1.5 Agricultural extension needs on the thematic area of Marketing under up to date Information dimension

Table 6.44 reflects the farmers' preferences of agricultural extension needs on the thematic area of marketing under up to date Information dimension for increasing agricultural disasters resilience. The result indicates that the farmers mostly prefer the information namely which products have a high demand in the market with highest average Garret score of 54.87 to develop strategic mitigation plan for minimizing the impact of farm disasters. The second most preferred information is current prices of agricultural produce with second highest average Garret score of 51.87 for taking the appropriate farm production marketing decision to enhance resilience

capacity against farm disasters. The other preferred information extension needs to mitigate the impact of farm disasters according to farmers' priority are improved marketing practices and Online market information.

Table 6.44: Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of Marketing under up to date Information dimension

Dimension	Thematic area	Extension need items	Garrett Score	Rank
A.Up to date Information	**V. Marketing**	1.Online market information	47.46	**IV**
		2. Information on which products have a high demand in the market	54.87	**I**
		3.Information on improved marketing practices	49.80	**III**
		4. Information on current prices	51.87	**II**

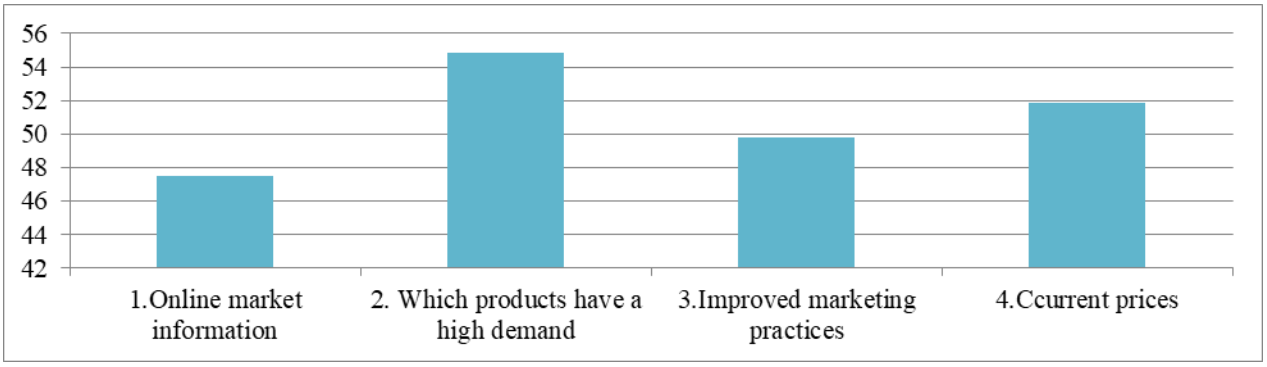


Fig.6.39: Diagrammatic representation of Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of Marketing under up to date Information dimension

6.4.1.6 Agricultural extension needs on the thematic area of livelihood diversification under up to date Information dimension

Table 6.45 presents the farmers' preferences of agricultural extension needs on the thematic area of livelihood diversification under up to date Information dimension for increasing agricultural disasters resilience and ensuring livelihood security. The result indicates that the farmers mostly prefer the information namely ancillary occupation to increase household income with highest average Garret score of 53.60 to develop strategic mitigation plan for minimizing the impact of farm disasters. The second most preferred information is integrated farming system with second highest average Garret score of 51.275 for taking the appropriate farm enterprise decision to

enhance farm disasters resilience capacity. The third preferred information is how and when one should change the farm enterprise combination with average Garret score of 50.75 for easing the decision making process for appropriate farm enterprise combination to avert the negative impact of farm disasters .The other preferred information extension needs to mitigate the impact of farm disasters according to farmers' priority are crop diversification through low volume high value product and innovations that are capable of boosting farm productivity and economic development.

Table 6.45: Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of livelihood diversification under up to date Information dimension

Dimension	Thematic area	Extension need items	Garrett Score	Rank
A.Up to date Information	**VI. Livelihood diversification**	1. Information for ancillary occupation to increase household income	53.60	**I**
		2. Information on Integrated Farming System	51.275	**II**
		3. Information on crop diversification through low volume high value product	48.475	**IV**
		4. Information on how and when should you change the farm enterprise combination (e.g. agril. diversification)	50.75	**III**
		5.Information on innovations that are capable of boosting farm productivity and economic development	45.7	**V**

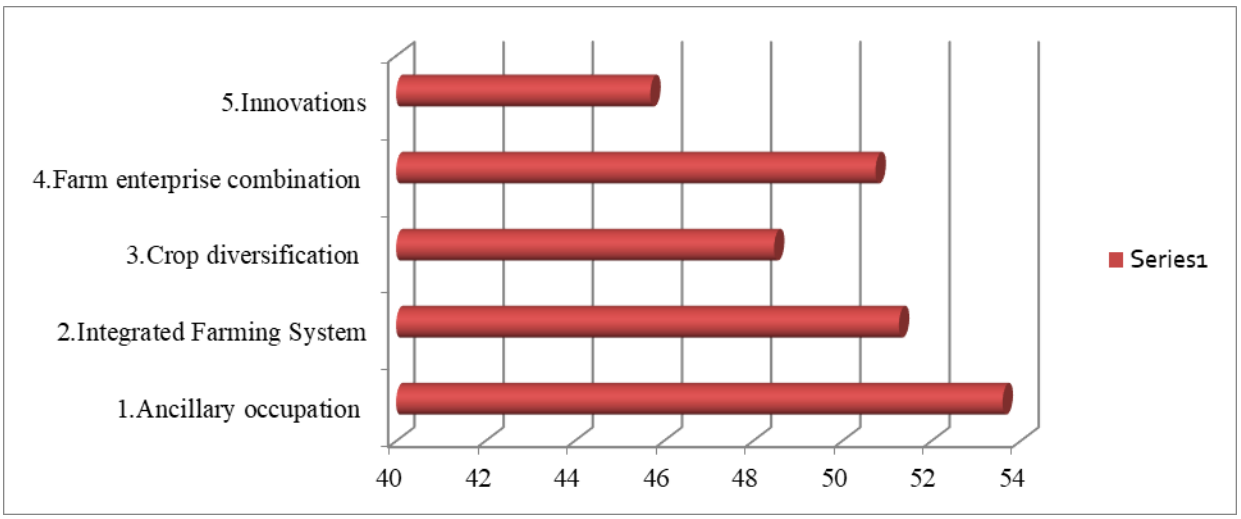


Fig.6.40: Diagrammatic representation of Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of Post harvest management under up to date Information dimension

6.4.2.1 Agricultural extension needs on the thematic area of agricultural inputs under Advisory Service (Training & Demonstration) dimension

Table 6.46 indicates the farmers' preferences of agricultural extension needs on the thematic area of agricultural inputs under Training & Demonstration dimension to mitigate agricultural disasters and ensuring food security. The result indicates that the farmers mostly prefer the Training & Demonstration namely efficient use of seeds with highest average Garret score of 53.16 to develop skill for its optimum use in pre and post disaster preparedness. The second most preferred Training & Demonstration is efficient use of fertilizers with second highest average Garret score of 50.60 to develop skill for its optimum use in pre and post disaster preparedness. The third preferred Training & Demonstration is efficient measure of Plant protection with average Garret score of 50.60 for develop strategic pest and disease adaptation and mitigation action plan for minimizing the impact of farm pest and disease disasters/.The other preferred Training & Demonstration extension needs to mitigate the impact of farm disasters according to farmers' priority are efficient use Irrigation and Farm implements and machineries that are capable of boosting farm productivity and economic development

Table 6.46: Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of agricultural inputs under Advisory Service (Training & Demonstration) dimension

Dimension	Thematic area	Extension need items	Garrett Score	Rank
B.Advisory Service (Training & Demonstration)	**I. Agricultural inputs**	Training and/or Demonstration on efficient use of Agricultural Inputs		
		1.Seeds	53.16	**I**
		2.Fertilizers	50.60	**II**
		3.Irrigation	44.475	**IV**
		4. Plant protection	49.75	**III**
		5.Farm implements and machineries	43.475	**V**

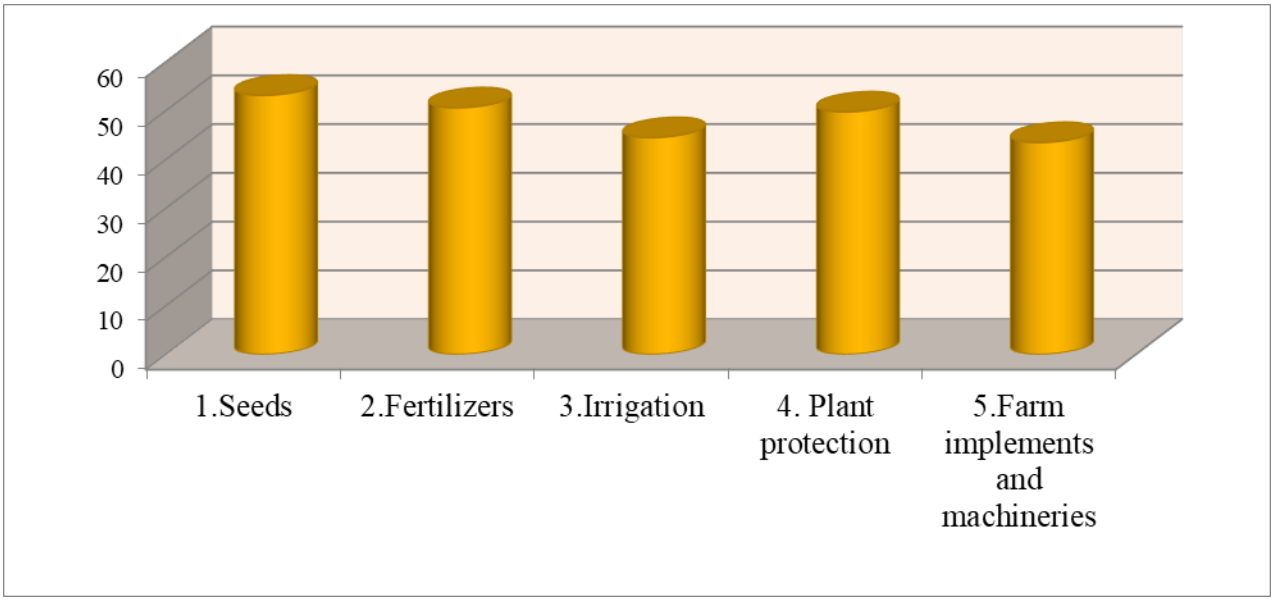


Fig.6.41: Diagrammatic representation of Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of agricultural inputs under Advisory Service (Training & Demonstration) dimension

6.4.2.2 Agricultural extension needs on the thematic area of agricultural finance under Advisory Service (Training & Demonstration) dimension

Table 6.47 presents the farmers' preferences of agricultural extension needs on the thematic area of agricultural finance under Training & Demonstration dimension for agricultural disasters management and ensuring livelihood security. The result indicates that the farmers mostly prefer the Training & Demonstration on crop insurance (PMFBY) with highest average Garret score of 53.92 to develop knowledge and skill for enhancing disaster preparedness. The other preferred Training & Demonstration extension needs to mitigate the impact of farm disasters according to farmers' priority are agricultural subsidies and KCC/Credit that are capable of boosting farmer disaster resilience.

Table 6.47: Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of agricultural finance under Advisory Service (Training & Demonstration) dimension

Dimension	Thematic area	Extension need items	Garrett Score	Rank
B.Advisory Service (Training & Demonstration)	**II.Agricultural finance**	Training and/or Demonstration on the agricultural finance related issues		
		1.KCC/Credit	46.90	**III**
		2.Crop Insurance(PMFBY)	53.92	**I**
		3.Subsidies	49.20	**II**

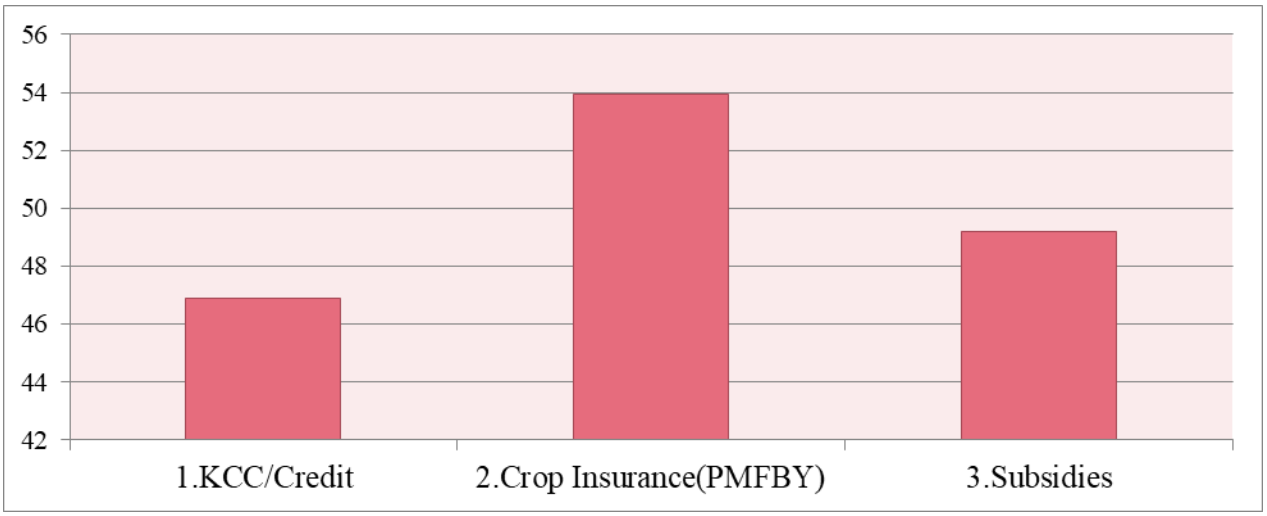


Fig.6.42: Diagrammatic representation of Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of agricultural finance under Advisory Service (Training & Demonstration) dimension

6.4.2.3 Agricultural extension needs on the thematic area of agricultural production under Advisory Service (Training & Demonstration) dimension

Table 6.48 reflects the farmers' preferences of agricultural extension needs on the thematic area of agricultural production under Training & Demonstration dimension for agricultural disasters management and ensuring food security. The result indicates that the farmers mostly prefer the Training & Demonstration namely flood and drought resistant crop varieties with highest average Garret score of 54.2 to develop knowledge and skill for enhancing flood and drought disaster resilience. The second most preferred Training & Demonstration is preparedness/crop contingency planning against natural calamities or disaster/hazards with second highest average Garret score of 51.32 to develop knowledge and skill for crop contingency planning during pre and post disaster preparedness. The other preferred Training & Demonstration extension needs to mitigate the impact of farm disasters according to farmers' priority are pest and disease management, and soil health and nutrient management that are capable of boosting farm productivity and sustainable agricultural production.

Table 6.48: Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of agricultural production under Advisory Service (Training & Demonstration) dimension

Dimension	Thematic area	Extension need items	Garrett Score	Rank

B.Advisory Service (Training & Demonstration)	**III.Agricultural production**	Training and/or Demonstration on the agricultural production & management aspects		
		1.Soil health and nutrient management	46.42	**IV**
		2.Pest and Disease management	49.89	**III**
		3.Preparedness/crop Contingency planning against natural calamities or disaster/hazards	51.32	**II**
		4. Flood and drought resistant crop varieties.	54.2	**I**

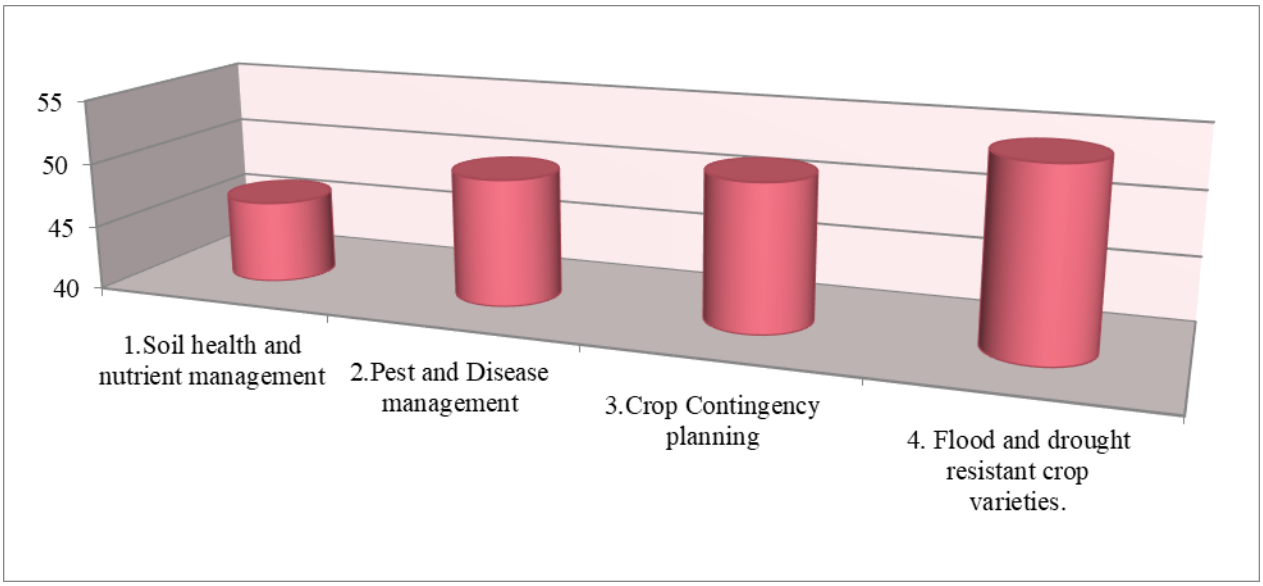


Fig.6.43: Diagrammatic representation of Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of agricultural production under Advisory Service (Training & Demonstration) dimension

6.4.2.4 Agricultural extension needs on the thematic area of post harvest management under Advisory Service (Training & Demonstration) dimension

Table 6.49 presents the farmers' preferences of agricultural extension needs on the thematic area of post harvest management under Training & Demonstration dimension for increasing their agricultural disasters resilience and economic development. The result indicates that the farmers mostly prefer the Training & Demonstration namely Packaging with highest average Garret score of 52.91 to develop knowledge and skill for safeguarding the agricultural produce and fetching remunerative price in the market and thereby enhancing the farm disaster resilience. The second most preferred Training & Demonstration is Storing with second highest average Garret score of 51.6to develop knowledge and skill for proper and scientific storage of agricultural

produce which increases the resilience capacity of farmers against disasters. The other preferred Training & Demonstration extension needs to mitigate the impact of farm disasters according to farmers' priority are processing, value addition and grading of agricultural produce that are capable of enhancing their economic development.

Table 6.49: Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of post harvest management under Advisory Service (Training & Demonstration) dimension

Dimension	Thematic area	Extension need items	Garrett Score	Rank
B.Advisory Service (Training & Demonstration)	**IV. Post Harvest Management**	Training and/or Demonstration on the agricultural post harvest activities		
		1.Processing	50.6	**III**
		2.Value addition	48.75	**IV**
		3.Storing	51.6	**II**
		4.Grading	46.2	**V**
		5. Packaging	52.91	**I**

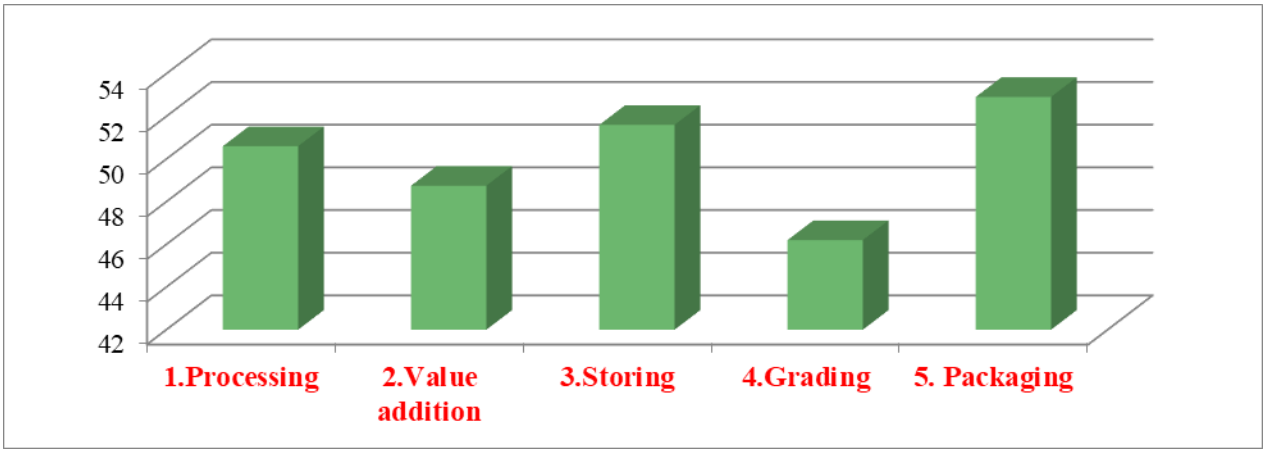


Fig 6.44: Diagrammatic representation of Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of post harvest management **under Advisory Service (Training & Demonstration) dimension**

6.4.2.5 Agricultural extension needs on the thematic area of livelihoods diversification under Advisory Service (Training & Demonstration) dimension

Table 6.50 presents the farmers' preferences of agricultural extension needs on the thematic area of livelihoods diversification under Training & Demonstration dimension for increasing their agricultural disasters resilience and economic development. The result shows that the farmers mostly prefer the Training & Demonstration namely Entrepreneurship Development with highest

average Garret score of 54.4 to develop knowledge and skill for exploring new avenues of economic development based on their available resources and thereby enhancing the farm disaster resilience. The second most preferred Training & Demonstration is Custom Hiring Centre with second highest average Garret score of 53.29 to develop knowledge and skill for management and establishment of custom hiring centre which increases the resilience capacity of farmers against disasters. The other preferred Training & Demonstration extension needs to mitigate the impact of farm disasters according to farmers' priority are agricultural diversifications, secondary agriculture , integrated farming system and crop diversifications(high value Crops) that are capable of enhancing their economic development.

Table 6.50: Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of livelihoods diversification under Advisory Service (Training & Demonstration) dimension

Dimension	Thematic area	Extension need items	Garrett Score	Rank
B.Advisory Service (Training & Demonstration)	**IV. livelihoods diversification**	Training and/or Demonstration on the following livelihoods diversification activities		
		1.Agricultural Diversifications	49.45	**III**
		2.Crop Diversifications(High value Crops)	46.25	**VI**
		3.Integrated Farming System	48.4	**V**
		4.Entrepreneurship Development	54.4	**I**
		5.Secondary Agriculture	49.3	**IV**
		6.Custom Hiring Centre	53.29	**II**

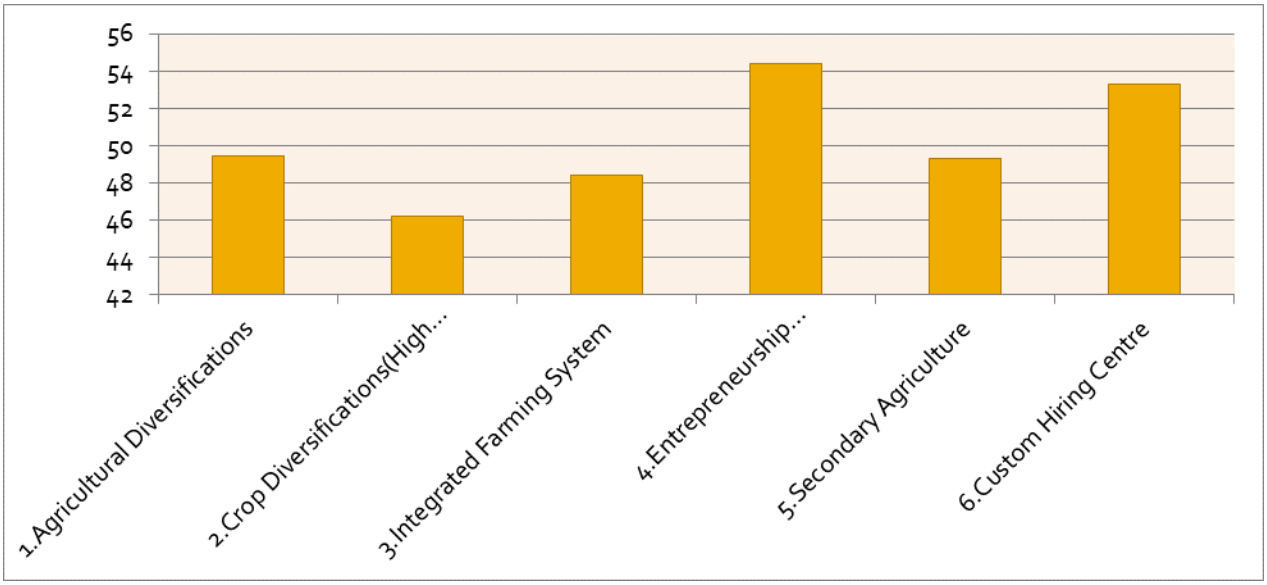


Fig.6.45: Diagrammatic representation of Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of livelihoods diversification under Advisory Service (Training & Demonstration) dimension

6.4.3.1 Agricultural extension needs on the thematic area of Agricultural production under Mitigation strategy dimension

Table 6.51 presents the farmers' preferences of agricultural extension needs on the thematic area of Agricultural production under Mitigation strategy dimension for increasing their agricultural disasters resilience and ensuring food security. The result shows that the farmers mostly prefer the Mitigation strategy namely cultivating flood tolerant rice varieties with highest average Garret score of 54.13 to adopt strategic adaptation plan for minimizing the negative impact of flood disasters and thereby enhancing their disaster resilience. The second most preferred Mitigation strategy is Practising In-situ rain water harvesting for moisture conservation (mulching) with second highest average Garret score of 51.92 to mitigate the dry spell in crop production cycle which increases the resilience capacity of farmers against drought like situation. The third most preferred Mitigation strategy is Practicing Mixed cropping and inter cropping with third highest average Garret score of 51.52 to minimize the crop production loses. The other preferred Mitigation strategy extension needs to minimize the impact of farm disasters according to farmers' priority are Cultivating medium duration *Sali* rice Cultivar for dry spell management, Crop diversification for flood water management, Cultivating Maize in the driest period of the year, Cultivating Short duration *Sali* rice Cultivar for pre flood situation, Practising Rain water harvesting in farm ponds in raising seedling of *Sali* rice, Cultivating short duration *Sali* rice

cultivar for dry spell management, Cultivating short duration Boro rice (Summer season) varieties for escaping flood, Practising Rain water harvesting in farm ponds for growing rabi crops, Crop diversification for dry spell management, Use of organic manure (vermicompost/compost) for drought/ dry spell management in *Sali* rice, .Application of NPK for drought management in *Sali* rice, Cultivating short duration pulses such as green gram, black gram, cowpea and millet for escaping drought like situation, Cultivating Short duration *Sali* rice Cultivar for post flood situation, Diversification of Farming system, Practising protected cultivation of high value crops against hail storm and Cultivating drought tolerant rice varieties that are capable of enhancing their disaster resilience.

Table 6.51: Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of Agricultural production under Mitigation strategy dimension

Dimension	Thematic area	Extension need items	Garrett Score	Rank
C. Mitigation Strategy	**II.Agricultural production**	1.Cultivating flood tolerant rice varieties	54.13	**I**
		2.Cultivating drought tolerant rice varieties	47.21	**XIX**
		3.Cultivating short duration *Sali* rice cultivar for dry spell management	49.94	**IX**
		4.Cultivating medium duration *Sali* rice Cultivar for dry spell management	51.07	**IV**
		5. Crop diversification for flood water management	50.94	**V**
		6.Crop diversification for dry spell management	49.44	**XII**
		7.Cultivating Short duration *Sali* rice Cultivar for post flood situation	48.63	**XVI**
		8.Cultivating Short duration *Sali* rice Cultivar for pre flood situation	50.84	**VII**
		9.Cultivating short duration Boro rice (Summer season) varieties for escaping flood	49.78	**X**
		10.Cultivating short duration pulses such as green gram, black gram, cowpea and millet for escaping drought like situation	49.00	**XV**
		11.Cultivating Maize in the driest period of the year	50.86	**VI**
		12.Practising Rain water harvesting in farm ponds for growing rabi crops	49.57	**XI**
		13. Practising Rain water harvesting in farm ponds in raising seedling of *Sali* rice	50.68	**VIII**
		14. Use of organic manure (vermi	49.31	**XIII**

		compost/compost) for drought/ dry spell management in *Sali* rice		
		15.Application of NPK for drought management in *Sali* rice	49.02	**XIV**
		16.Practising protected cultivation of high value crops against hail storm	47.65	**XVIII**
		17.Practising In-situ rain water harvesting for moisture conservation(mulching)	51.92	**II**
		18. Practicing Mixed cropping and inter cropping	51.52	**III**
		19. Diversification of Farming system	48.39	**XVII**

6.4.3.2 Agricultural extension needs on the thematic area of Institutional Building under Mitigation Strategy dimension

Table 6.52 presents the farmers' preferences of agricultural extension needs on the thematic area of Institutional Building under Mitigation strategy dimension for increasing their agricultural disasters resilience and sustainable agricultural production. The result shows that the farmers mostly prefer the Mitigation strategy namely Establishing Custom Hiring Centre with highest average Garret score of 54.32 to adopt strategic adaptation plan for post disaster agricultural preparedness mainly relating to farm mechanization and thereby enhancing their disaster resilience. The second most preferred Mitigation strategy is establishing Regulated Market with second highest average Garret score of 52.56 for fetching the appropriate price of farm produce which increases the resilience capacity of farmers against distress sale. The third most preferred Mitigation strategy is Establishing Seed Bank with third highest average Garret score of 50.36 to make the seed available in pre and post disaster ensuring the food security . The other preferred Mitigation strategy extension needs to minimize the impact of farm disasters according to farmers' priority are Establishing FPO/FPC and Establishing fodder bank that are capable of enhancing their disaster resilience.

Table 6.52: Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of Institutional Building under Mitigation Strategy dimension

Dimension	Thematic area	Extension need items	Garrett Score	Rank
A. Mitigation Strategy	**II. Institutional Building**	1. Establishing Seed Bank	50.36	**III**
		2. Establishing fodder bank	44.85	**V**
		3. Establishing Custom Hiring Centre	54.32	**I**
		4. Developing FPO/FPC	49.71	**IV**
		5.Regulated Market	52.56	**II**

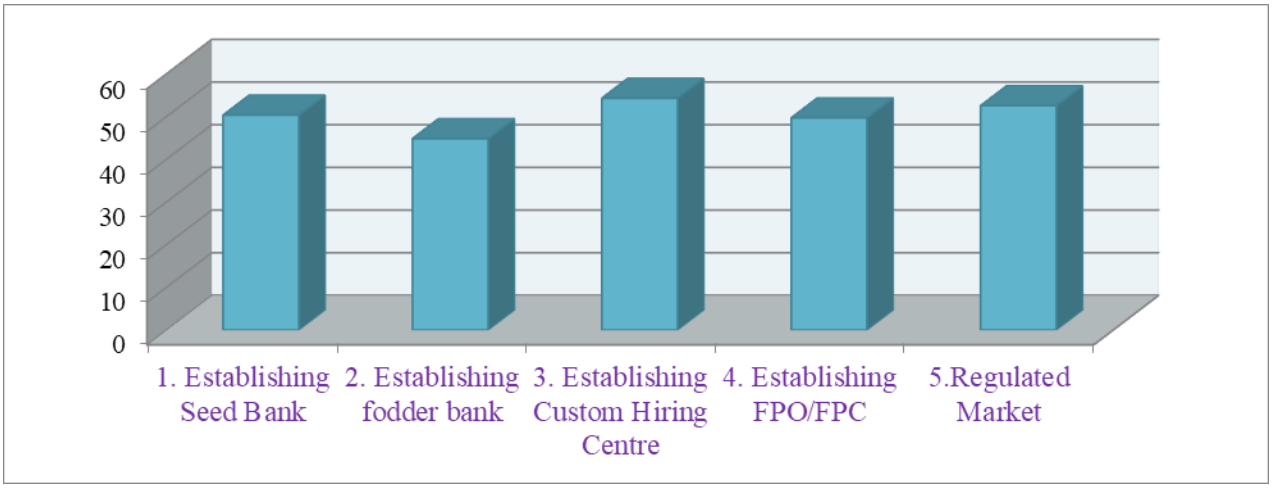


Fig.6.46: Diagrammatic representation of Garrett's ranking of farmers' preferences of agricultural extension needs on the thematic area of Institutional Building under **Mitigation Strategy dimension**

6.5 Challenges associated with farmers' agricultural extension needs and disaster resilience

Present study also examines various challenges associated with farmers' agricultural extension needs and disaster resilience under four categories namely socio economic challenges; technical challenges; physical and infrastructural, and organizational/institutional challenges. To assess the challenges associated with farmers' agricultural extension needs and disaster resilience, respondent farmers are asked to rank identified challenges as per their perception. And their responses are taken through interview schedule. The Garrette Ranking Technique is used to rank the challenges associated with farmers' agricultural extension needs and disaster resilience under above mentioned four categories.

6.5.1 Farmers' Socio economic challenges associated with agricultural extension needs and disaster resilience

Table 6.53 and fig.6.47 presents the ranking of respondents' socio economic challenges associated with agricultural extension needs and disaster resilience. The result shows that the farmers mostly faced the problem of lack of exposure to agricultural development with highest average Garret score of 56.32. The second most faced problem is inadequate access to training and demonstration with second highest average Garret score of 55.89.The third most experienced problem is lack of crop insurance facilities with third highest average Garret score of 53. The other faced socio economic challenges associated with agricultural extension needs and disaster

resilience are inadequate subsidy facilities; poor level of awareness and education level; poor adoption of improved agricultural technologies; multidimensional extension needs; lack of formal credit facilities; complexity of the demonstrated technologies; and reluctant to change existing practices. It is observable that a host of socio-economic challenges are there to fulfill the agricultural extension needs of farmers and increasing their disaster resilience level in the study area. The challenges may be grouped as educational, agricultural finance, technology related and traditional mind set. These challenges can be mitigated by executing a series of agricultural extension awareness events; training and demonstration programmes with location specific agricultural technologies, exposure visit events and motivational programmes. Moreover, a massive drive or campaign regarding agricultural finance including agricultural loan and crop insurance may be organized in the rural area for enhancement of framers disaster resilience

Table 6.53: Garrett's ranking of farmers' Socio economic challenges associated with agricultural extension needs and disaster resilience

Sl.No.	Socio economic challenges	Garrett Score	Rank
1	Poor level of awareness and education level	**52.22**	**V**
2	Reluctant to change existing practices	**43.54**	**X**
3	Poor adoption of improved agricultural technologies	**49.23**	**VI**
4	Lack of exposure to agricultural development	**56.32**	**I**
5	Poor perception and understanding on the Technologies	**42.32**	**XI**
6	Complexity of the demonstrated Technologies	**44.20**	**IX**
7	Inadequate access to training and demonstration	**55.89**	**II**
8	Multidimensional extension needs	**48.41**	**VII**
9	Lack of formal credit facilities	**44.87**	**VIII**
10	Lack of crop insurance facilities	**53.96**	**III**
11	Inadequate subsidy facilities	**53.73**	**IV**

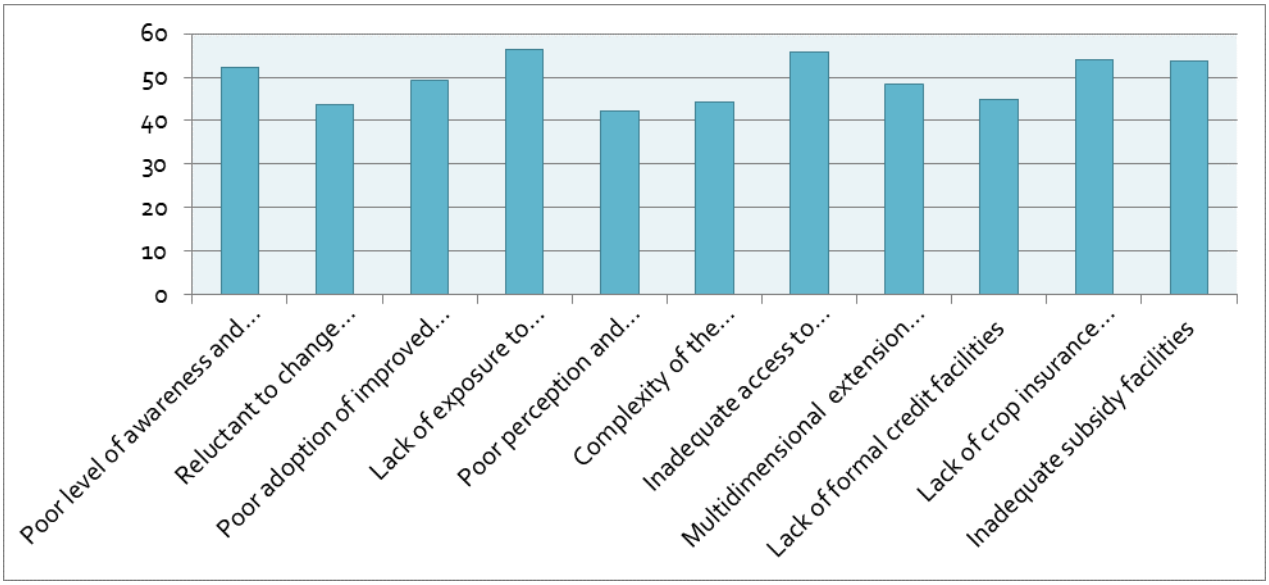


Fig.6.47: Diagrammatic representation of Garrett's ranking of farmers' Socio economic challenges associated with agricultural extension needs and disaster resilience

6.5.2 Farmers' Technical challenges associated with agricultural extension needs and disaster resilience

Table 6.54 presents the ranking of respondents' technical challenges associated with agricultural extension needs and disaster resilience. The result shows that the farmers mostly faced the problems of unpredictability nature of disaster events with highest average Garret score of 56.63. The second most faced problem is various type/natures of disaster and their changing magnitude level with second highest average Garret score of 55.12. The third most experienced problem is changing weather pattern with third highest average Garret score of 54.32. The other faced technical challenges associated with agricultural extension needs and disaster resilience are Poor access to disaster resilience agricultural technology; poor crop contingency planning; non availability of timely farm advisories; poor knowledge of improved farm disaster management practices; lack of available location specific disaster resilience agricultural technology; poor access to early warning system and non availability of weather report in local language. It is vivid from the table that technical challenges that are prioritized by farmers can be grouped or specified as disaster and ICT related; and agricultural technology and extension related. Appropriate disaster related extension educational interventions coupled with information and communication technologies (ICT) applications; training and demonstrations of disaster resilience agricultural technology and crop Contingency planning may be the some solution to

minimize the impact of farm disaster. With the help of ICT or mass media, farmer can be aware of weather report, farm advisories and early warning system which will enhance the their disaster resilience for sustainable agricultural production. Govt. should take appropriate plan and policy to mitigate the above challenges for empowering the farming community against all kind of farm disasters.

Table 6.54: Garrett's ranking of farmers' Technical challenges associated with agricultural extension needs and disaster resilience

Sl.No.	Technical challenges	Garrett Score	Rank
1	Changing weather pattern	54.32	III
2	Various type/natures of disaster and their changing magnitude level	55.12	II
3	Unpredictability nature of disaster events	56.63	I
4	Poor knowledge of improved farm disaster management practices	47.12	VII
5	Lack of available location specific disaster resilience agricultural technology	44.38	VIII
6	Poor access to disaster resilience agricultural technology.	51.86	IV
7	Poor crop Contingency planning	51.26	V
8	Poor access to early warning system	44.23	IX
9	Non availability of weather report in local language	43.39	X
10	Non availability of timely farm advisories.	48.69	VI

6.5.3 Farmers' Physical and Infrastructural challenges associated with agricultural extension needs and disaster resilience

Table 6.55 and fig.6.48 presents the ranking of respondents' Physical and Infrastructural challenges associated with agricultural extension needs and disaster resilience. The result shows that the farmers mostly faced the problem of Irrigation facilities with highest average Garret score of 54.57. The second most faced problem is Non availability Cold storage facilities with second highest average Garret score of 54.12. The third most experienced problem is non availability of training institute nearby with third highest average Garret score of 52.64. The other faced physical and infrastructural challenges associated with agricultural extension needs and disaster resilience are poor ICT infrastructure; poor transportation facilities; non availability of extension functionaries office nearby; poor road condition and connectivity; lack of training hall with standard facilities; poor communication network and lack of farm drainage facilities.It is observable from the table that a sizeable numbers of physical and infrastructural challenges are

prioritized by farmer respondents, which can be grouped as farm, ICT, training and transportation infrastructure related that are associated with agricultural extension needs and disaster resilience. With Adequate and appropriate Govt. policy and its effective implementation regarding establishment of irrigation facilities for increasing cropping intensity, cold storage facilities for storing and appropriate marketing, ICT facilities for communication, transport facilities for carrying farm produce and training infrastructure for knowledge and skill development, will help to increase farmers resilience against various farm disasters

Table 6.55: Garrett's ranking of farmers' Physical and Infrastructural challenges associated with agricultural extension needs and disaster resilience

Sl.No.	Physical and Infrastructural Challenges	Garrett Score	Rank
1	Poor ICT Infrastructure	52.08	IV
2	Non availability of Training Institute nearby	52.64	III
3	Lack of Training Hall with standard facilities	44.51	VIII
4	Lack of Irrigation facilities	54.57	I
5	Non availability Cold storage facilities	54.12	II
6	Lack of farm drainage facilities	43.11	X
7	Poor Transportation facilities	50.74	V
8	Poor road condition and connectivity	45.87	VII
9	Poor communication Network	43.77	IX
10	Non availability of Extension functionaries office nearby	48.22	VI

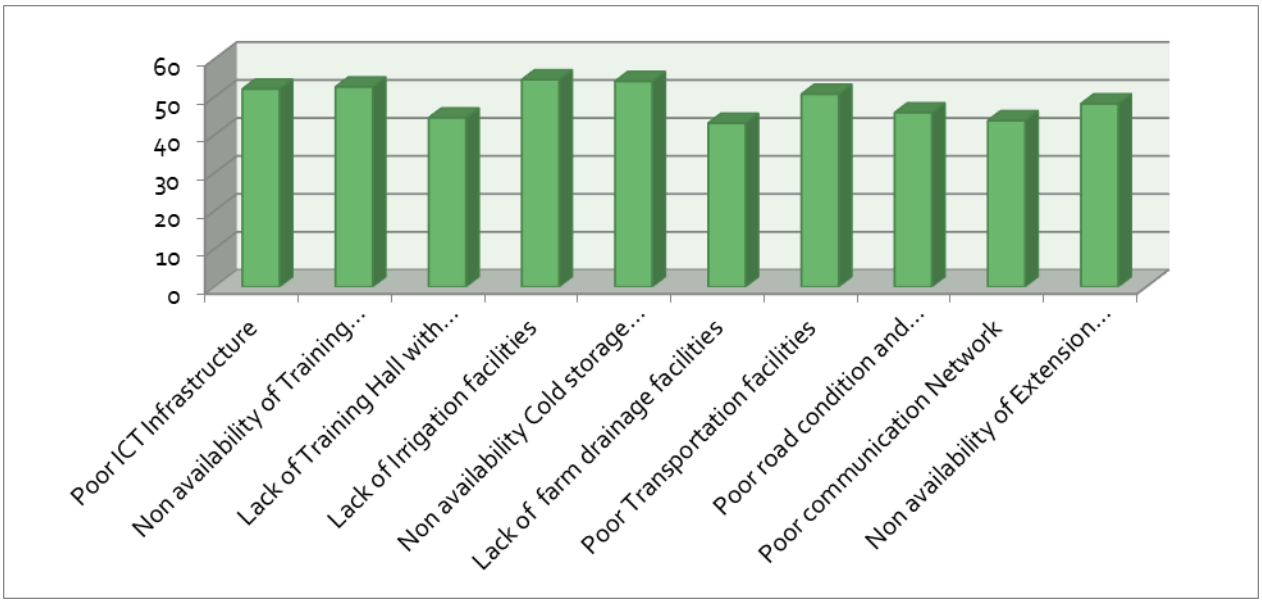


Fig.6.48: Diagrammatic representation of Garrett's ranking of farmers' Physical and Infrastructural challenges associated with agricultural extension needs and disaster resilience

6.5.4 Farmers' Organizational/Institutional challenges associated with agricultural extension needs and disaster resilience

Table 6.56 and fig.6.49 presents the ranking of respondents' Organizational/Institutional challenges associated with agricultural extension needs and disaster resilience. The result shows that the farmers mostly faced the problem of lack of agricultural shop nearby with highest average Garret score of 54.93. The second most faced problem is lack of custom hiring centre with second highest average Garret score of 54.38 .The third most experienced problem is lack of seed bank with third highest average Garret score of 53.85. The other faced organizational/institutional challenges associated with agricultural extension needs and disaster resilience are lack of regulated market; non availability of FPO/FPC/CIG and non availability of fodder bank. It is vivid from the table that organizational/institutional challenges that are prioritized by farmers can be identified as agriculture input, farm mechanization ,market and social participation related .Appropriate Govt. policy and programmes for establishment of organizational/institution such as seed and fodder bank for post disaster need of seeds; agricultural shop for various immediate needs of farm inputs ; regulated market for marketing of farm produce ; farmer producer company for procurement of farm inputs and selling of farm produce and custom hiring centre for various farm operation including land prepatation,will facilitate the farming community to avert the effect of farm disaster .

Table 6.56: Garrett's ranking of farmers' Organizational/Institutional challenges associated with agricultural extension needs and disaster resilience

Sl.No.	Organizational/Institutional Challenges	Garrett Score	Rank
1	Lack of Seed Bank	53.85	III
2	Non availability of fodder bank	44.87	VI
3	Lack of Custom Hiring Centre	54.38	II
4	Non availability of FPO/FPC/CIG	48.77	V
5	Lack of Regulated Market	51.53	IV
6	Lack of agricultural shop nearby	54.93	I

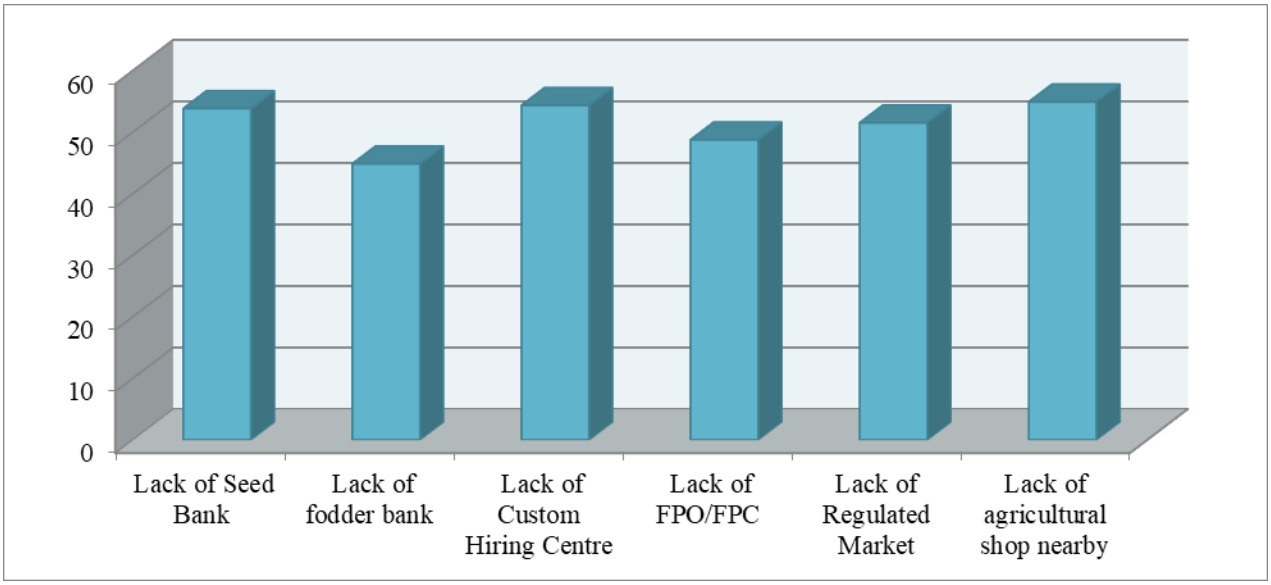


Fig.6.49: Diagrammatic representation of Garrett's ranking of farmers' Organizational/Institutional challenges associated with agricultural extension needs and disaster resilience.

6.6. Strategic paradigm for farmers' agricultural extension needs and disaster resilience

Fussy Cognitive Mapping (FCM) is used to develop strategic paradigm for farmers' agricultural extension needs and disaster resilience. Three paradigms were identified through Fuzzy Cognitive mapping and relational analyses, Paradigm I is depicted by Fuzzy cognitive mapping and Paradigm II and III are developed from relational analyses.

STRATEGIC PARADIGM-I

6.6.1 Development of Fuzzy Cognitive Maps

In the study a mixed-concept design approach is followed for developing cognitive maps involving open-concept design and closed-concept design. Expert-based FCM is developed using open concept design. A total of 35 experts comprising of specialist, scientist and professor of national institution identify18 categories of main components and 71 sub- components. The visual representation of this expert-based FCM model is depicted in Fig. 6.50.

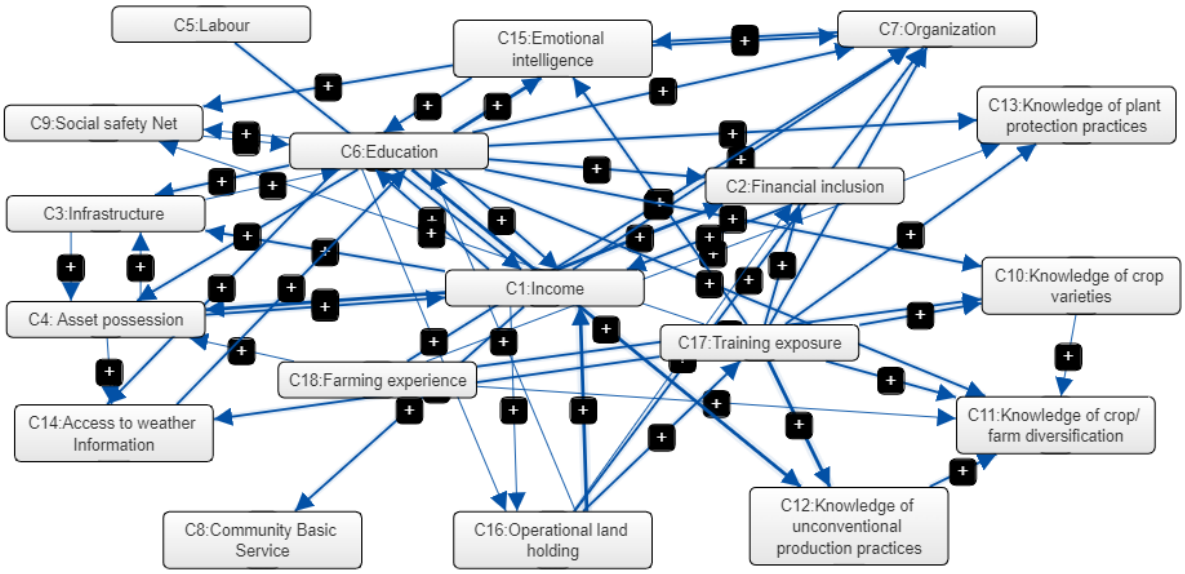


Fig.6.50: Expert based FCM Model on farmer disaster resilience constructed using fuzzy-logic cognitive mapping software Mental Modeler

There are a set of sub- component under each main component introduced by the experts for better understanding of the examined problem and making it understandable to the farmer respondents. Table 6.57 indicates all the sub- components for each key component. A multistage purposive cum random sampling design is adopted for selecting the 200 farmer respondents from two blocks covering four villages in each block for the study. A total of 200 individual fuzzy cognitive maps are recorded during FCM exercise with the selected farmer respondents. All the

selected farmer respondents of the villages are also asked to assign a numerical value (degree of significance) to every sub- components on a scale of 1–10 in order to assess the impact of each sub- components to the corresponding key components. An overall average degree of significance is calculated for every key component to estimate the significance of each component in the examined FCM model.

Individual fuzzy cognitive maps are coded into separate excel sheets to form adjacency matrices. The values are coded into the square matrix only when a connection existed between two concepts. Weights given to each link are then normalised between 0 and +1(the value 3 is normalised to 0.3) for coding into the adjacency matrix. All coded maps are aggregated using the weighted average aggregation methods. Individual FCMs are aggregated to form collective-FCM through matrix addition. The collective-FCM represents the perception of all selected farmers respondents of the Dhemaji district.

Considering *n* stakeholders assign a weight value w_{ij}, between the nodes C_i and C_j on individual FCMs, then the aggregated weight $w^{(ave)}_{ij}$ between the average value of the *n* weights w_{ij}:

$$W(^{ave})_{ij} = \frac{w^{(1)}_{ij} + w^{(2)}_{ij} + \cdots + w^{(n)}_{ij}}{n}$$

Table 6.57: The sub components for each of the key components

Key Components	Sub Components
C1:Income	Diversity of Income source, Off-season Income Recovery of income owing to a recent flood Financial help from family members and relatives
C2:Financial Inclusion	Access to credit facility for farming activities Access to credit facility to prevent flood disaster Availability of subsidies for field drainage infrastructure Availability of subsidies for flood resistant agri inputs Crop insurance accessibility, Household saving practice
C3: Infrastructure Facility	Proper storage facilities, Cold storage facilities Irrigation facilities, Field drainage facilities Good road connectivity, Electricity for agricultural purpose
C4: Asset possession	Radio,TV,Computer with internet Mobile phones with Internet, Mobile phones without Internet Motorized vehicle, Water pump, Farm tractor/power tiller Improved farm tools and implements
C5: Labour	Household contribution to farm labour Contribution of extended family members/relatives towards farm labour

C6: Education	Formal education Awareness level about climate change Availability of public awareness programmes on flood disaster Access to internet/social media Access to Extension and Advisory Service
C7: Organization	Members of any farmer based organization(FBO,SHG,FPC,CIG etc) Activeness in any Farmer based organization Years of membership in FBOs,Access to seed bank Access to Custom Hiring Centre
C8: Community Basic Service	Access to Health care, Access to Drinking water Access Shelter/safe house, Access to Electricity Access to Transport
C9:Social safety Net	Availability of Assistance in cash/ kind Availability of (Job assistance/MGNREGA Availability of PDS,Availability of Old Age pension Scheme Availability of Relief material, Availability of IAY/PMAY
C10: Knowledge of crop varieties	Knowledge of flood resistant Varieties Knowledge of drought resistant Varieties Knowledge of early maturing varieties
C11: Crop/ farm diversification	Knowledge of intercropping, Knowledge of relay Cropping Knowledge of mixed Cropping, Knowledge of crop rotation Knowledge of multiple cropping Knowledge of integrated farming System
C12: Knowledge of unconventional production practices	Poly house/green house cultivation etc Knowledge of changed planting/sowing dates
C13: Knowledge of plant protection practices	Knowledge of IPM,Knowledge of IDM Knowledge of ITK(IPPP)
C14: Access to weather Information	Access to daily weather Data Access to flood disaster Warnings Access to weather predictions from reliable sources (GKMS/IMD etc.) Knowledge of applications/websites developed for sharing climate/weather information
C15: Emotional intelligence	Self Awareness, Self Motivation Social awareness, Social Skills
C16: Land holding	Total size of operational land holding Land tenure system, Elevation of land
C17: Training exposure	Training on improved agricultural practices Training on Farm disaster management and preparedness Training on marketing of farm produce Training on farm contingency planning
C18: Farming experience	Year of farming

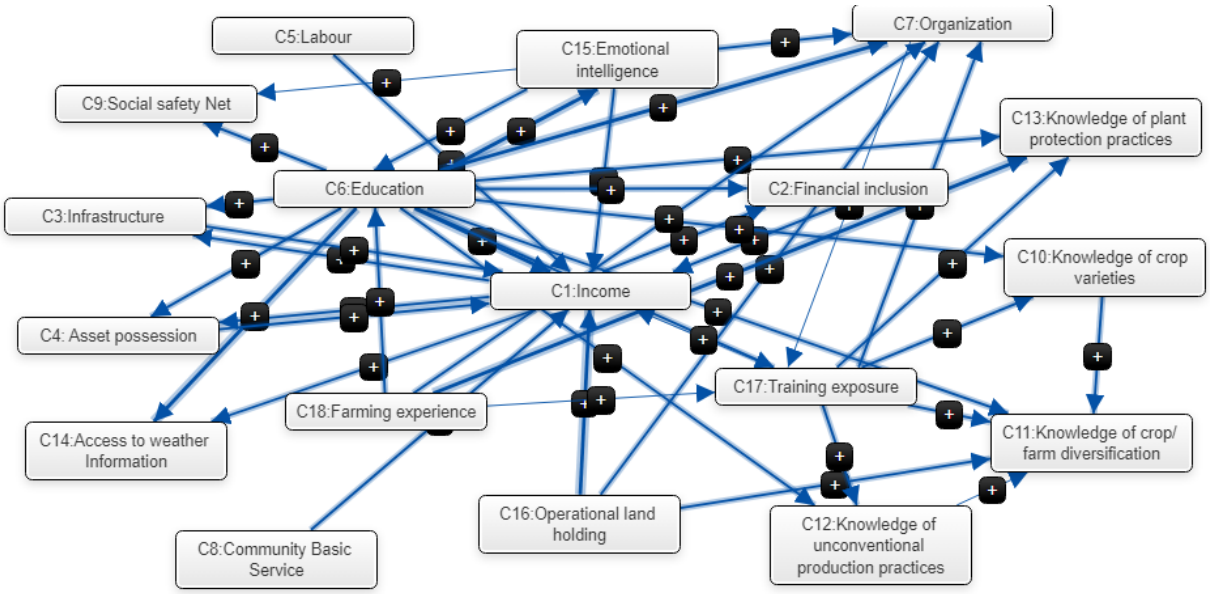


Fig.6.51: Farmer based FCM Model constructed using fuzzy-logic cognitive mapping software Mental Modeler

6.62 Characteristics of the key components of the farmers' disaster resilience

There are sizeable numbers of components in the study. It is necessary to keep the most affecting components to examine a particular component in depth. The filtering technique of key components is common in scenario planning and helps linking storylines to the quantitative model, as well as to pay attention to pivotal components that can influence, directly or not, the outcome of the examined system, or even significantly change its balance**.** There are three indicators, based on the connection weights, which help researchers to recognize the important key concepts of the system-indegree (weight of inbound links), outdegree (weight of outbound links), and degree centrality. The first two indicate to what extent a concept is a transmitter (influential) or receiver (dependent). This is similar to the bi-dimensional categorization of influence-dependence axes in cross-impact analysis. Degree centrality is the relative importance of a component within the FCM structure, which is calculated by the sum of the corresponding absolute indegree and outdegree causal weights**.** These calculated indices for the collective average-FCM, along with the identified components, are summarized in Table 6.58.

Table 6.58: Characteristics the collective average-FCM

Key Components	Description	Indegree	Outdegree	Centrality	Type
C1:Income	Wages, profits, off-season income, financial help and other forms of income	2.88	1.39	4.27	ordinary
C2:Financial inclusion	Access to credit , subsidies , crop insurance and household saving practice	0.81	0.24	1.0	ordinary
C3:Infrastructure	Improved storage ,cold storage, irrigation , drainage ,good road connectivity, electricity	0.67	0.3	0.98	ordinary
C4: Asset possession	Mass media tools ,farm mechanization implements, tractors etc	0.75	0.46	1.21	ordinary
C5:Labour	Contribution of family, extended family members/relatives towards farm labour	0	0.2	0.2	driver
C6:Education	Formal education, awareness of climate change, flood disaster, access to internet/social media, extension and advisory service	0.54	5.51	6.05	ordinary
C7:Organization	Membership and activeness of any farmer based organization, access to seed bank, custom hiring centre	1.64	0.13	1.77	ordinary
C8:Community Basic Service	Access to health care, drinking water, shelter/safe house, electricity ,transport	0	0.19	0.19	driver
C9:Social safety Net	Availability of assistance in cash/ kind, job, assistance/MGNREGA PDS, old age pension, relief material, PMAY	0.62	0	0.62	receiver

C10:Knowledge of crop varieties	Knowledge of flood , drought resistant, early maturing varieties	0.65	0.19	0.84	ordinary
C11:Knowledge of crop/ farm diversification	Knowledge of intercropping, relay & mixed copping, crop rotation, multiple cropping ,integrated farming system etc	1.35	0	1.35	receiver
C12:Unconventional production practices	Poly house/green house cultivation , knowledge of changed planting/sowing dates	0.67	0.16	0.83	ordinary
C13:Knowledge of plant protection practices	Knowledge of IPM, IDM and ITK(IPPP)	1.27	0	1.27	receiver
C14:Access to weather Information	Access to daily weather data, flood disaster warnings, weather predictions, knowledge of climate/weather related apps/	0.87	0	0.87	receiver
C15:Emotional intelligence	Self Awareness and Motivation, Social awareness and Skills	0.51	1.02	1.53	ordinary
C16:Land holding	Total size of operational land holding Land tenure system Elevation of land etc	0	1.11	1.11	driver
C17: Training exposure	Training on improved agricultural practices, farm disaster management and preparedness, marketing of farm produce, farm contingency planning	0.48	1.79	2.27	ordinary
C18:Farming experience	Year of farming	0	1.03	1.03	driver

6.63 Characteristics of the sub concepts of the farmers' disaster resilience

All sub concepts of every key concept are administered to each respondent to assign a degree of significance in a continuum of 1-10, where 10 is the most significant sub concept and 1 is the least significant sub concept. The procedure was followed in all selected eight villages under two Community Development Block jurisdiction of Dhemaji district of Assam, India. Table 6.59 includes the key concepts with the respective mean values for both Blocks, as well as the overall average value of the degree of significance.

Table 6.59: Mean values of significance for two blocks and the average degree of significance

Key Components	Degree of Significance(Mean Value)		Average Degree of significance
	Machkhowa Block	Murkong Selek Block	
C1:Income	8.00	7.875	7.937
C2:Financial inclusion	7.87	7.97	7.92
C3:Infrastructure	7.12	6.86	6.99
C4: Asset possession	6.76	6.96	6.86
C5:Labour	5.85	6.12	5.985
C6:Education	7.48	7.65	7.565
C7:Organization	5.86	5.43	5.645
C8:Community Basic Service	7.67	7.90	7.785
C9:Social safety Net	8.12	8.64	8.38
C10:Knowledge of crop varieties	7.65	8.67	8.16
C11:Knowledge of crop/ farm diversification	6.87	7.67	7.27
C12:Knowledge of unconventional production practices	5.76	6.86	6.31
C13:Knowledge of plant protection practices	5.23	5.45	5.34
C14:Access to weather Information	4.89	5.60	5.245
C15:Emotional intelligence	7.23	7.67	7.45
C16:Operational land holding	7.38	7.11	7.24
C17:Training exposure	8.21	7.24	7.72
C18:Farming experience	5.40	5.60	5.5

It is observable from the Table 6.60 that component C1: Income, C6: Education and C17: Training exposure is having highest values of degree of significance and centrality among all the components. Additionally, it is examined that earlier selected components are most significant ones while comparing these values with the corresponding centrality of the aggregated and expert based FCM model.

Table 6.60: The average degree of significance and centrality values of all key components

Key Components	Average Degree of significance	Expert based centrality	Farmer based centrality
C1:Income	7.937	4.37	4.27
C2:Financial inclusion	7.92	1.60	1.0
C3:Infrastructure	6.99	0.9	0.98
C4: Asset possession	6.86	1.85	1.21
C5:Labour	5.985	0.19	0.2
C6:Education	7.565	5.46	6.05
C7:Organization	5.645	1.98	1.77
C8:Community Basic Service	7.785	0.34	0.19
C9:Social safety Net	6.38	0.67	0.62
C10:Knowledge of crop varieties	7.16	0.92	0.84
C11:Knowledge of crop/ farm diversification	7.27	0.90	1.35
C12:Knowledge of unconventional production practices	6.31	1.12	0.83
C13:Knowledge of plant protection practices	5.34	0.82	1.27
C14:Access to weather Information	5.245	1.01	0.87
C15:Emotional intelligence	7.45	1.99	1.53
C16:Operational land holding	7.24	1.58	1.11
C17:Training exposure	7.72	3.44	2.27
C18:Farming experience	5.5	0.77	1.03

The study identified key and respective sub components aimed at increasing the disaster resilience of farming community. The components income, education, knowledge of crop/ farm diversification, operational land holding and training exposure have significant impact in enhancing farmers' disaster resilience. Access to credit facility, subsidies schemes, crop insurance, farmer based organization and mass media with farm mechanization machineries play crucial role in strengthening the socio-economic resilience of the farmers. The findings reflect

that knowledge of crop varieties, unconventional production practices, plant protection practices, farming experience and emotional intelligence are critical components to address issue of socio-personal disaster resilience of farming community. Infrastructure such as proper storage structure, cold storage, irrigation, drainage, proper road and electricity connectivity also enhances the farmers' resilience level. Access to daily weather data, flood disaster warnings and weather predictions are also important for increasing farmers' technical resilience against farm disaster. Thus, the components income, education, knowledge of crop/ farm diversification, operational land holding and training exposure have significant role in the policy making and strategic planning for enhancing farmers' disaster resilience.

6.64 Scenario Development

The first approach in scenario planning is the selection of most important key components. The most important components are identified for the scenario analysis which affect the status of the system being examined. During the FCM exercise, it is also collected the degree of significance of every key component on the basis of the perception of farmer participants of study area and thus most significant components are identified of the system. On the basis of the FCM models prepared by the farmer respondents, it can be inferred that C1: Income, C6: Education, and C17: Training exposure are the most significant components, which are likely to have considerable impacts on the system. These components, marked by the farmer respondents, are selected systematically based on the highest centrality, having both in/out-degree values, and the highest degree of significance among all key components (see Table 6.60). Thus, they could significantly influence the dynamics of the system. The selected scenarios with their components are presented in the Table 6.61.

Table 6.61: The Key components selected for scenario development

Scenarios	**Components**
Scenario-1(S1)	C1: Income
Scenario-2(S2)	C6: Education
Scenario-3(S3)	C17: Training exposure

6.64.1 FCM based Simulations/Scenario analysis

6.64.1.1 Scenario-1(S1): Simulated effect of Income on others key Components

FCM based simulations/scenario analysis is conducted for the three selected cases. The scenario analysis shows how much the model's individual components are changed in relation to one another. Scenario-1(S1) examined the effects of income in terms of diversity of income source, off-season income, recovery of income loss and financial help. The selected key component-income is set to a value of +1 (substantial positive change) to develop the scenario-1(S1). The relative change in the system is represented as a bar graph to show how various components are affected. It is observable from the Fig. 6.52 that organization accession(0.02unit), financial inclusion(0.03unit), education(0.01), infrastructure(0.02), asset possession(0.03unit), community basic service(0.02) and operational land holding (0.01unit) are increased against the substantial positive change (+1) of key component-Income. It means that high income leads to more financial inclusion, asset possession, organization accession, operational land holding and more access to community basic service. Ultimately high income empowers the farming community and increases their resilience against the flood disaster.

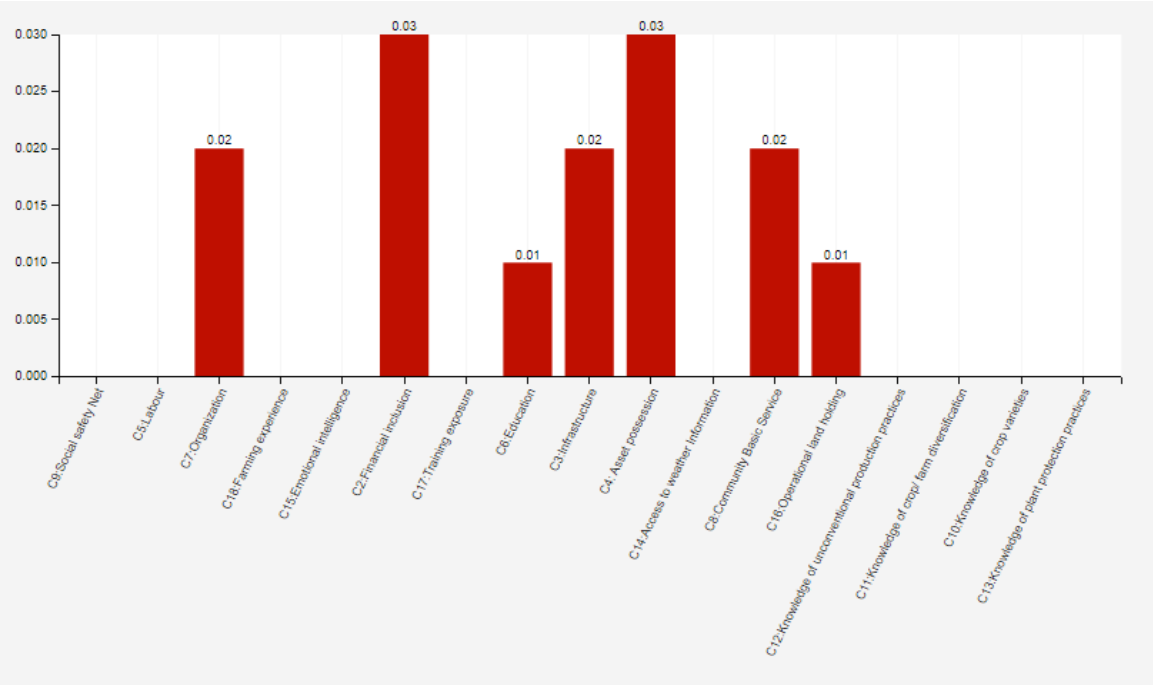


Fig.6.52: Diagrammatic representation of simulated effect of Income on others key components

6.64.1.2 Scenario-2(S2): Simulated effect of Education on others key Components

Scenario-2(S2) highlighted the effects of education in terms of formal education; awareness to climate change and disasters; access to internet/social media and extension and advisory service. The selected key component- education is set to a value of +1 (substantial positive change) to develop the scenario-2(S2). The relative change in the system is represented as a bar graph to show how various components are affected. It is vivid from the Fig.6.53 that social safety net (0.01unit), organization accession (0.02unit), income(0.02unit), emotional intelligence(0.04unit), financial inclusion(0.03unit), infrastructure(0.02unit), asset possession(0.02unit), access to weather information(0.03unit) operational land holding(0.01unit), knowledge of unconventional production practices(0.04 unit), knowledge of crop/ farm diversification(0.03 unit), knowledge of crop varieties(0.02 unit) and knowledge of plant protection practices (0.03 unit) are increased against the substantial positive change (+1) of key component-education. Education plays crucial role in developing farmers' resilience level against flood disaster. Scenario analysis indicates that social safety net and organization accession; income and financial inclusion; infrastructure and asset possession; access to weather information; operational land holding; emotional intelligence and knowledge of unconventional production practices, crop/ farm diversification, crop varieties plant protection practices are increased as farmers' education level is increased.

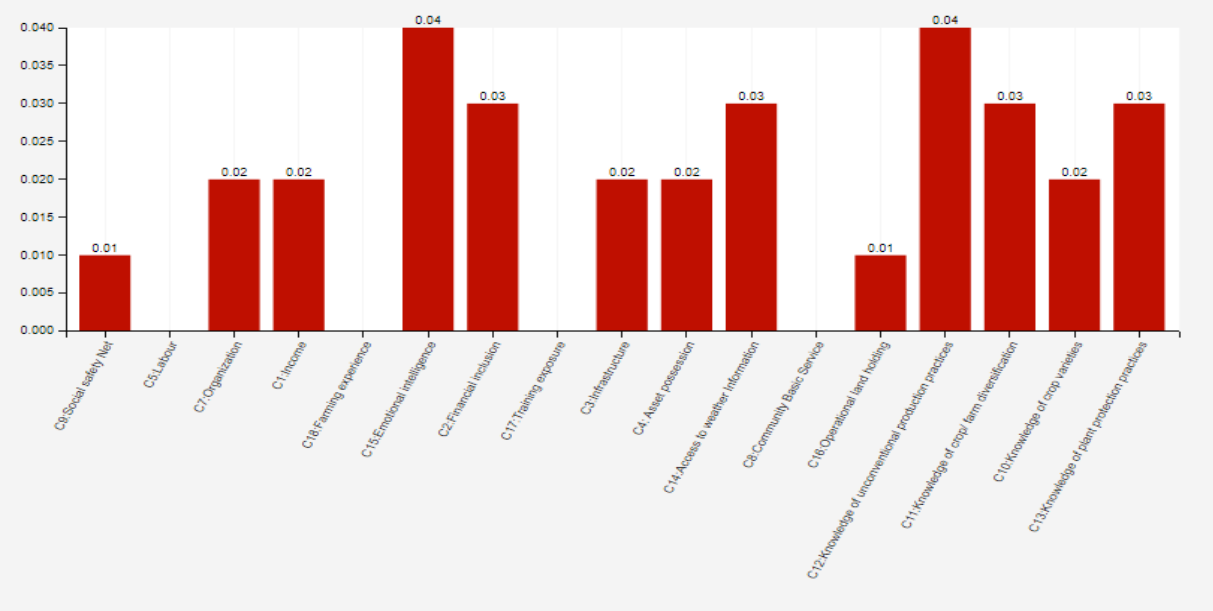


Fig.6.53: Diagrammatic representation of simulated effect of Education on others key components

6.64.1.3 Scenario-3(S3): Simulated effect of Training exposure on other key components

Scenario-3(S3) examined the effects of training exposure in terms of improved agricultural practices, farm disaster management and preparedness, marketing of farm produce and farm contingency planning etc. The selected key component-Training exposure is set to a value of +1 (substantial positive change) to develop the scenario-3(S3). The relative change in the system is represented as a bar graph to show how various components are affected. It is emerged from the Fig.6.54 that social safety net accession (0.02 unit), organization accession (0.04unit), emotional intelligence (0.04unit), financial inclusion (0.02), access to weather information (0.03),knowledge of unconventional production practices(0.06 unit), knowledge of crop/ farm diversification(0.05 unit), knowledge of crop varieties(0.05 unit) and knowledge of plant protection practices (0.04 unit) are increased against the substantial positive change (+1) of key component- training exposure. Training enhances the knowledge and imparts skills that facilitate the farmers to cope the situation of flood disaster. Scenario analysis indicates that social safety net and organization accession; emotional intelligence; financial inclusion; access to weather information, and knowledge of unconventional production practices, crop/ farm diversification, crop varieties plant protection practices are increased as farmers' training exposure is increased.

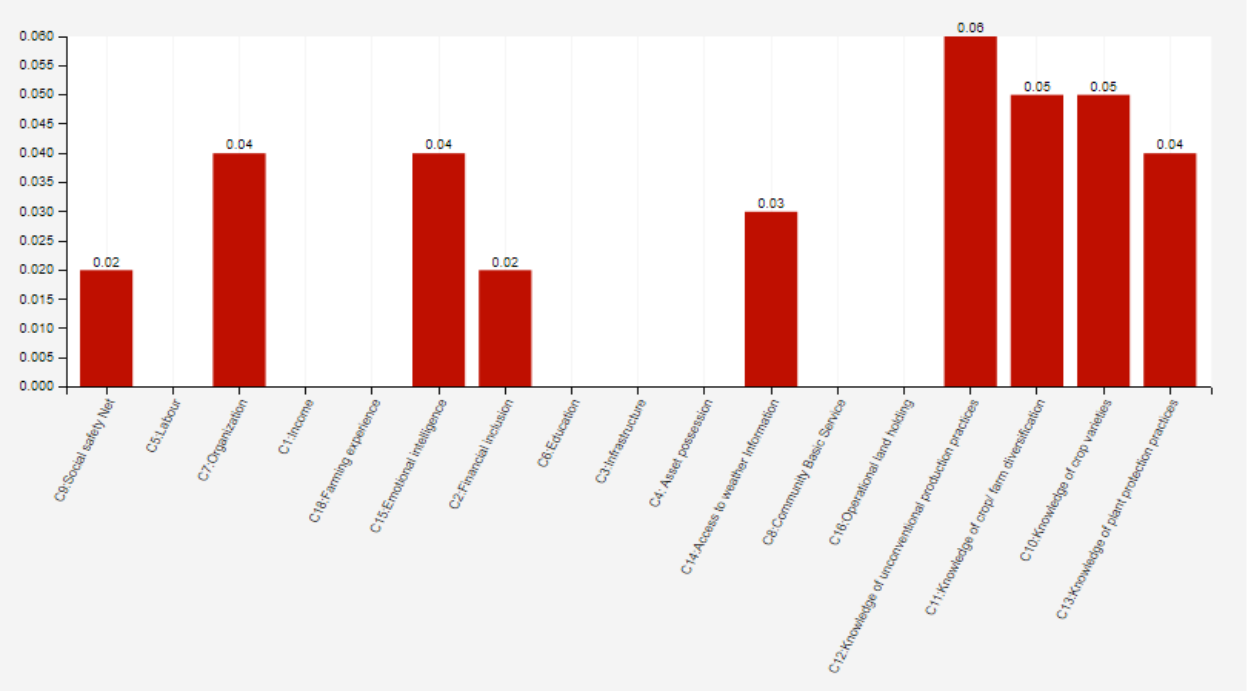


Fig. 6.54: Diagrammatic representation of simulated effect of Training exposure on other key components

STRATEGIC PARADIGM-II

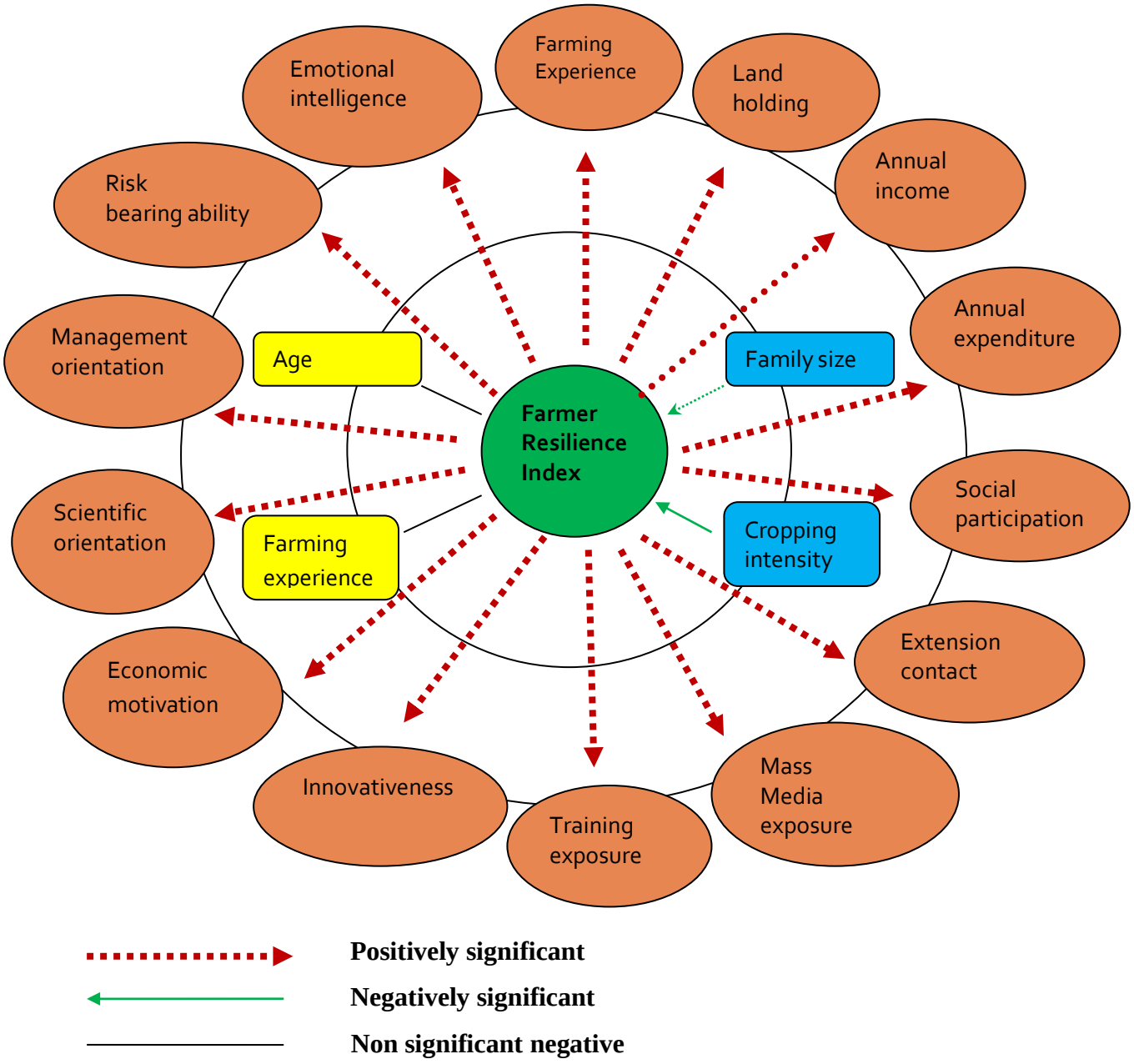


Fig.6.55: Strategic Paradigm-II for farmers' disaster resilience

Agriculture is highly sensitive to climate changes and extreme weather events such as droughts, floods and severe storms, which have a direct negative impact on crop production , productivity and other agricultural production base posing threat to livelihood and food security to millions of farmers. It is stated that most of the farmers are lack knowledge and resources to adequately mitigate, anticipate, prepare for, cope with, and recover from disaster shocks. Apart from Govt. policies and programmes, attributes or characteristics of farmer play major role in mitigating the

farm disasters and hazards. The study identified the association of socio personal, economic, psychological and communication characteristics of farmers with their disaster resilience level.

In the context of climate change and global warming, farmer has to be more prompt, knowledgeable and skillful to face the untoward incidence of multiple farm disaster to sustain their livelihood and food security. Already a bunch of disaster resilience farm technologies are available with university and research institute and are being developed to mitigate the disaster impact. These technologies are also integrated with extension and farm advisory system and transfer of technology programmes. Farmer can avert the effect of disaster by adopting these resilient farm technologies Farmer has to increase their socio-economic status by increasing education level, land holding and income to mitigate the impact of disaster. Extension and communication attributes of farmers can play major roles in developing their resilience level against disaster. Farmer should increase their social participation, extension contact, mass media exposure and training exposure to face the challenges of multiple farm disasters. Socio-Psychological attributes are also another important aspect for farmer disaster resilience. Farmer has to increase their economic motivation, scientific orientation, management orientation, risk bearing ability, innovativeness and emotional intelligence level to manage the farm disaster situation. This is the need of the hour to suggest a new strategy for the same. The one strategy is not enough with the solution for mitigating farm disaster and hazards. In this context, there is a requirement of integration of socio personal, economic, psychological and communication characteristics of farmers to develop and suggest a strategy/model for developing their disaster resilience. The newly suggestive farmer centric strategy considers all the research outcomes received from this research and prepared a holistic strategy by incorporating/involving the characteristic of farmer namely socio personal, economic, psychological and communication characteristics to mitigate the impact of farm disasters. The following suggestive extension system may fit for the same and can be fully proven after implementing the strategy at large scale by incorporating it into the future policy implications.

STRATEGIC PARADIGM-III

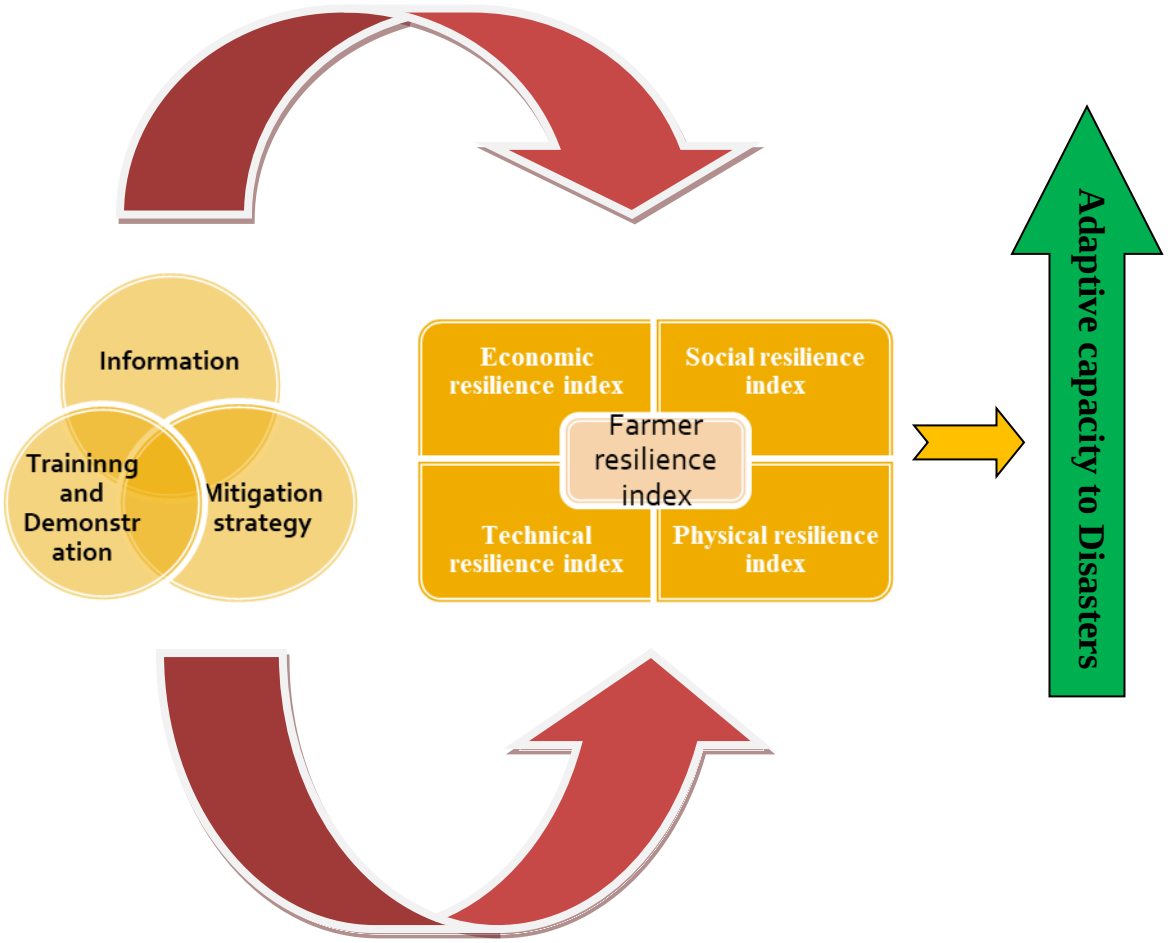


Fig.6.56: Strategic Paradigm-III for farmers' disaster resilience

Over the time the frequency and intensity of natural disaster are increasing across the globe and agricultural production base is being affected. In the present situation the extension and advisory service system has to accommodate the issue of agricultural disasters and hazards in its responsibilities as top priorities. However, in order to increase the farmers' disaster resilience, there is need for change in roles, responsibilities and capacity in the extension system so as to accommodate the new challenges and dimensions brought about by multiple disasters. The three ways namely agricultural information, Training and demonstration, and Extension disaster mitigation strategies can play pivotal roles in increasing farmers' resilience and adaptation to various farm disasters. In the present study the extension needs on various thematic areas under three dimensions are identified and existing extension and advisory system is not at all adequate to provide an enabling environment for averting disaster risk in agriculture. Moreover, farmers are lack knowledge and resources to adequately mitigate, anticipate, prepare for, cope with and

recover from disaster shocks. So, there is a requirement of reformed extension system to avert disaster vulnerability in agriculture ensuring sustainable agricultural production. This is the need of the hour to suggest a reformed extension system or strategy for the same. The one extension strategy is not enough with the solution for mitigating the global issue like agricultural disaster and hazards. In this context, there is a requirement of integration of three identified agricultural extension needs dimension such as information; training and demonstration and disaster mitigating extension strategy with four disaster resilience dimension to develop and suggest a revamped extension and advisory system for developing farmers' disaster resilience. The newly suggestive extension system considers all the research outcomes received from this research and prepared a holistic extension strategy by incorporating/involving the four dimensions of farmer disaster resilience framework namely economic resilience, social resilience, technical resilience and physical resilience and timely advisory support to mitigate the impact of farm disasters. The following suggestive extension system may fit for the same and can be fully proven after implementing the strategy at large scale by incorporating it into the future policy implications.

6.7. Accepted Hypothesis

The accepted hypotheses after testing in the present study are as follows

$H_1$1: There are differences of the attributes among farmers in the study area

$H_1$2: There are relationships among the attributes of farmers and resilience score

$H_1$3: There are priorities of agricultural extension needs among farmers

PART-II

To support the empirical outcomes of the present study there is a need of descriptive case study. For this reason, some of the success stories are collected and presented for better understanding of the research problem and the solution provided by the empirical analytical conclusions.

Success Story-A

Title: Application of mulching technology for moisture conservation in high value King Chilli crop

Mr. Pranab Bora, a young educated small farmer of age 31 years belong to village Baghgao under Chimen Chapori panchayat of Murkong Selek Development Block. Initially he was practising traditional agriculture with his father. Due to recurrent occurrence of flood, dry spells, storm, hailstorms disasters in the locality, their agricultural production base are threatened and damaged leading to heavy yield loss and exposed them to food and livelihood insecurity. Once, Mr. Bora had a chance to attend an extension awareness programme conducted by State Deptt. of Agriculture and he learned about high value horticultural crops. Subsequently he talked and discussed with friends and other stakeholders about the high value horticultural crops particularly King Chilli.He started growing King Chilli in a small plot of their operational land holding. At the beginning, he faced a lot of problems in managing the crops such as weeds, moisture stress and marketing of the produce. Over the years, he learned and adopts the mulching technology for managing weeds and moisture of the crops with rice straw as well as plastic sheets and improved the marketing linkage with neigbouring state of Arunachal Pradesh and Nagaland. Adopting mulching technology, he manages the crops to grow well with satisfactory yield and fetches remunerative price in the market. Presently, Mr. Bora is cultivating King Chilli with king and queen varieties of the crop following scientific practices in an area of 0.5 ha. Now He is growing the two varieties of King Chilli in an area of 0.50ha of upland area realizing 168 qn productions. His cost of cultivation of the crop is almost Rs, 1,50,000/- and earn gross income from chilli cultivation is Rs. 4,20000/- with a net profit of Rs. 2,50,000/- in a one crop cycle. Nowadays, Mr. Bora is well known young farmer in the locality and many others are contacting him for King Chilli cultivation with agricultural technologies.

Revelation: Proper extension strategy or exposure and improved technologies can increase the farmers' disaster resilience.




Success Story-B

Title: Application of High Yielding Variety technology for higher yield in Rapseed oilseed crop.

Mr. Gangadhar Boro, 42 years old small farmer belong to village Nawkata under Murkong Selek Development Block in Jonai Sub Division of Dhemaji district. Initially he was practising traditional agriculture with numbers of agricultural and horticultural crop enterprises and animal husbandry enterprises. Like other farmers, his operational land holding is also affected by flood disaster every year in the locality placing them in a deplorable condition. It is his tough challenge to grow crops in Kharif season. Once, Mr. Boro attended an extension training programme conducted by District Agriculture Office, Dhemaji and learned about high yielding variety oilseeds crops. Subsequently he talked and discussed with fellow farmers about prospects of cultivation of oilseed crops in flood ravaged land in kharif season. He started growing rapeseed oilseed crop with the HYV, TS38 in a small plot of their operational land holding in Rabi season with the support of agricultural extension functionaries. On successful harvesting of the crops, next year, he sown the rapeseed crop with the HYV, TS38 in an area of 1.5 ha and realized very satisfactory yield 21 qn. His cost of cultivation of the crop was almost Rs, 35,000/- and earn a gross income from rapeseed cultivation was Rs. 1,05000/- with a net profit of Rs. 70,000/- in the flood free rabi season. Now a days, Mr. Boro is well known progressive farmer in the locality and many others are communicating him by seeing the performance and sustainability of the variety. Many young youths and farmer are coming together for group farming with the HYV TS38 of rapeseed crop in the flood ravaged areas of the locality in the rabi season for their employment and livelihood security.

Revelation: Exposure to technological backstopping and extension advisory services improves the score of farmers' disaster resilience.



Success Story-C

Title: Application of Ranjit Sub-1 Rice variety technology for flood prone area

Mr. Dharmeswar Basumatary, a 35 year old young progressive farmer of village No.4 Baligorah under Somkong panchayat of Murkong Selek Development Block. Initially he was practising traditional agriculture in an area of 3 ha with his other family members. Due to frequent occurrence of climate induced disaster mainly flood in the locality, they could not cultivate the rice in their land holding adequately and almost every year their rice crop is partially or fully damaged by flood hazard exposing them to food and livelihood insecurity. Once, Mr. Basumatary contacted village level extension functionaries and attended an extension training programme conducted by State Deptt. of Agriculture .In the training programme, he learned about package of practices of flood tolerant rice varieties. Subsequently he talked and discussed with friends, relatives and other stakeholders about the flood tolerant rice varieties. Finally he decided to cultivate Ranjit Sub-1 Rice variety in a small plot of their operational land holding as trial basis and received a satisfactory yield in spite of flood occurrence. In the subsequent Kharif season, he cultivated rice with Ranjit Sub-1 variety in an area of 1 ha of land and realized a yield of 30 qn. Mr. Basumatary spent almost Rs, 25,000/- and earned a gross income from rice cultivation was Rs. 60,000/- with a net profit of Rs. 35,000/- . Nowadays, Mr. Basumatary is popular young farmer and a key communicator in the locality and many others are contacting him for flood tolerant Ranjit Sub-1 Rice variety .Moreover, he has developed a strong working linkage with district agriculture office and supply Ranjit Sub-1 Rice variety seed to the agricultural department.

Revelation: Technical resilience of farmer and appropriate extension strategy with motivation can minimize the farm disaster risks.



CHAPTER-7



SUMMARY AND CONCLUSION

The entire research work is summarized and concluded in this chapter under following sub heads:

7.1 Summary

7.2 Conclusion and recommendations

7.1 Summary

Indian agriculture is prone to all possible hazards, which often end-up in disaster. Unique geo-climatic conditions make the country vulnerable to hazards and disasters. The common natural hazards in India are droughts, floods, cyclones, landslides, forest fires, avalanches and pest /disease outbreaks in plants and animals besides earthquake. Multiple disasters have high impact on farming community in terms of crop loss or reduced income and damaged agricultural production base. In context of disasters, resilience is defined as the capacity to absorb its impact, bounce back and even improve their previous status. Climate change can be identified by the increase in the occurrence of extreme climate events such as flood, droughts, landslides and forest fires. Society is very sensitive, complex and is highly affected by these extreme events (Easterling, 2000).As per projection of IPCC, Weather events are likely to become more severe, intense, and less predictable in the future. Extreme weather events may lead to disaster when the society or ecosystems are unable to cope with it effectively (IPCC 2007).Various impacts of climate disasters include unseasonal rainfall, degradation of soil resources, plant pest and disease outbreak, economic and political crises, which along with exponential population growth are adding pressure to the global food system as agriculture is highly vulnerable to such impacts, thus leading to food and nutritional insecurity worldwide(Rockstrom *et al*. 2009;Godfray *et al.*2010;Pretty *et al.*2010).It is a tough challenge to make farming systems and farmers are able to fulfill their agricultural production goal even in the presence of such random, unpredictable changes, or impacts. In recent years, the concept of resilience has been used increasingly to address such challenges faced by farmers in crop production system (Tendall *et al*. 2015).

Agricultural extension plays crucial role in boosting agricultural productivity, increasing food security and improving livelihood security of millions of farmers. Agricultural extension provides critical and technical support service for farming communities for meeting the new challenges such as flood, drought, cyclone etc confronting the agriculture. It is stated that though India's National Agricultural Research System has developed farm disaster mitigation technologies to help the farmers cope with the disasters mainly flood and drought, the

technologies have not reached the grass-root level functionaries in an adequate manner. Although there is well defined agricultural extension service in a country like India, it is observed/stated that agricultural extension systems or machinery faced the daunting task of providing the required service to meet the demand before, during and after the disaster strike in preparedness, mitigation and rehabilitation stage of the disaster management cycle. Many farmers developed their own strategies and followed indigenous disaster reduction practices to minimize the effect of farm disasters on production but failed because of recurrent and unpredictable occurrences of disasters with changing magnitude or intensity levels. And thereby farmers are losing their coping capacities with the natural farm disaster. Assessment of agricultural extension needs of disaster-affected farmers is crucial to develop a holistic extension plan and policies ensuring food and livelihood security for the disaster-ravaged farming community of the country. The study highlights the role resilience can play in addressing crop production challenges faced by farmers and set a foundation for planning appropriate agricultural extension strategy. Against this backdrop, the present study entitled "Assessment of Agricultural Extension Needs of Farmers for Disaster Resilience in Dhemaji district of Assam" has been designed with the following specific objectives

- To study the attributes of farmers in the study area
- To compute the farmers' disaster resilience and to isolate the factors associated with farmers' disaster resilience
- To identify the agricultural extension needs of farmers with their associated dimension for disaster resilience
- To identify the challenges associated with farmers' agricultural extension needs and disaster resilience
- To construct a strategic paradigm for farmers' agricultural extension needs and disaster resilience

A multistage, purposive-cum-random sampling technique was followed for selecting respondents of the study. The Dhemaji district of Assam was selected for study purposively. In the district Dhemaji, the blocks Murkong Selek and Machkhowa were selected randomly out of five Blocks A total of eight villages namely Lamajan Mising, Madhabpur, No. 2 Narayanpur and No. 2 Nawkata under Murkong Selek Tribal Development Block and Rajabari, Seujia Pathar, Khalihamari Na- Pamua and Solmara under Machkhowa Development Block were selected

randomly to carry out this study. An exhaustive list of farmers from each village was prepared with the help of the local people, local administrator (panchayat officials), block-level extension functionaries and Kishi Vigyan Kendra (KVK), Dhemaji. So, from the exhaustive list, 25 numbers of farmers from each village were selected randomly for the present study to constitute a total 200 numbers of farmer respondents.

The farmer resilience index, economic resilience index, social resilience index, technical resilience index, and physical resilience index were considered as the predicted or consequent or dependent variables in the present study. A set of other 18 predictor or causal or independent variables was considered to characterize the predicted variables in the perfect way. All these variables were operationalized and measured with the help of the slightly modified pre-constructed and tested scales. The data were collected with the help of a structured interview schedule through the personal interview method. The collected data were analyzed with the help of statistical tools like mean, standard deviation, coefficient of variations, correlation, regression, factor analyses, analysis of variance, artificial neuron network and Garrette's Ranking Technique

The results of the present study indicate that:

- ✓ Over half of the farmer respondents (59%) are under the age group of 32-61 years which reflects their enthusiastic, energetic and experienced nature.
- ✓ Most of the farmer respondents (74.50%) belong to a family with 2.24 - 3.62 educational score which means medium family education status.
- ✓ Majority of the farmer respondents (63.00%) are having 10-39 years of farming experience
- ✓ Majority of the farmer respondents (63%) are belonging to a family comprising of 4-7 members
- ✓ Most of the farmer respondents (63.50) are possessing 1.2-3.2 ha size of operational land holding.
- ✓ Majority of the farmer respondents (65.50%) are having110-136% cropping intensity
- ✓ Most of the farmer respondents (63.50%) belong to the annual income group of Rs 1,15,000/ - Rs 2,87,000/ .
- ✓ Majority of the farmer respondents (63.00%) belong to the annual expenditure group of Rs 1, 07,000/ - Rs2, 47,000/.

- ✓ An overwhelming majority of the farmer respondents (94%) belong to medium level social participation with 1-3 membership in organization.
- ✓ A vast majority of the farmer respondents (80.50%) belong to medium level extension contact with a score of 1-3.
- ✓ Over half of the farmer respondents (59%) belong to medium level mass media exposure with a score of 6-11.
- ✓ An overwhelming majority of farmer respondents (88.00%) belong to medium level training exposure with a score of 1-9.
- ✓ An overwhelming majority of the farmer respondents (87.00%) belong to medium level of innovativeness with a score of 2-9.
- ✓ A vast majority of the farmer respondents (83.50%) belong to medium level of economic motivation with a score of 23-31.
- ✓ Over half of the farmer respondents (55.50%) belong to medium level of scientific orientation with a score of 23-33.
- ✓ Majority of the farmer respondents (71.00%) belong to medium level of management orientation with a score of 38-52.
- ✓ Majority of the farmer respondents (73.0%), belong to medium level of risk bearing ability with a score of 21-25.
- ✓ Most of the farmer respondents (55.50%) belong to medium level emotional intelligence with a score of 80-118.
- ✓ Majority of the farmer respondents (61.0%) belong to medium level economic resilience index with a score of 0.43 - 0.57
- ✓ About half of the farmer respondents (50.50%) belong to medium level social resilience index with a score of 0.47 - 0.59.
- ✓ Most of the farmer respondents (64.50%) belong to medium level technical resilience index with a score of 0.51 - 0.63.
- ✓ Majority of the farmer respondents (76.0%) belong to medium level physical resilience index with a score of 0.36-0.44.
- ✓ Over half of the farmer respondent s(53.50.0%), belong to medium level farmer resilience index with a score of 0.53-0.57

- ✓ The variables namely operational land holding(X_5), annual income(X_7), annual expenditure(X_8), social participation(X_9), extension contact(X_{10}), mass media exposure(X_{11}), training exposure(X_{12}), economic motivation(X_{14}), scientific orientation(X_{15}), management orientation(X_{16}), risk bearing ability(X_{17}) and emotional intelligence(X_{18}) are positively and significantly associated with the dependent variable, economic resilience index(Y_1). On the other hand, the variables viz., age (X_1), farming experience(X_3), family size(X_4) and cropping intensity(X_6) are negatively and significantly associated with the dependent variable, economic resilience index(Y_1).
- ✓ The variables extension contact(X_{10}), economic motivation(X_{14}) and management orientation(X_{16}) are positively and significantly contributing towards characterizing the predicted variable economic resilience index.
- ✓ The R^2 value being 0.467, it is to infer that the eighteen predictor variables put together have explained 46.70% variation embedded with the predicted variable economic resilience index.
- ✓ The variables namely cropping intensity(X_6), management orientation(X_{16}), farmer resilience index(Y_5) are positively and significantly associated with the dependent variable, social resilience index(Y_2).On the other hand, the variables viz., operational land holding(X_5), annual income(X_7), extension contact(X_{10}) and economic motivation(X_{14}) are negatively and significantly associated with the dependent variable, social resilience index(Y_2).
- ✓ The variable management orientation(X_{16}) and scientific orientation(X_{15}) are positively and significantly contributing towards characterizing the predicted variable, social resilience index while other three variables namely operational land holding(X_{05}), economic motivation(X_{14}) and farming experience(X_{03}) are negatively and significantly contributing towards characterizing the predicted variable, social resilience index
- ✓ The R^2 value being 0.453, it is to infer that the eighteen predictor variables put together have explained 45.30% variation embedded with the predicted variable economic resilience index.
- ✓ The variables namely operational land holding(X_5), annual income(X_7), annual expenditure(X_8), social participation(X_9), extension contact(X_{10}), mass media exposure(X_{11}), training exposure(X_{12}), innovativeness(X_{13}), economic motivation(X_{14}),

scientific orientation(X_{15}), management orientation(X_{16}), risk bearing ability(X_{17}) and emotional intelligence(X_{18}) are positively and significantly associated with the dependent variable, technical resilience index(Y_3).On the other hand, the variables viz., farming experience(X_3) and cropping intensity(X_6) are negatively significantly associated with the dependent variable, technical resilience index(Y_3).

- ✓ The variable scientific orientation(X_{15}), management orientation(X_{16}), age(X_{01}), economic motivation(X_{14}) and annual expenditure(X_{08}) are positively and significantly contributing towards characterizing the predicted variable, technical resilience index while other two variables namely Training exposure(X_{12}) and Cropping intensity(X_{06}) are negatively and significantly contributing towards characterizing the predicted variable, technical resilience index.
- ✓ The R^2 value being 0.583, it is to infer that the eighteen predictor variables put together have explained 58.30% variation embedded with the predicted variable economic resilience index..
- ✓ The variables namely age (X_1), family education(X_2), farming experience(X_3),operational land holding(X_5), annual income(X_7), annual expenditure(X_8), social participation(X_9), extension contact(X_{10}), mass media exposure(X_{11}), training exposure(X_{12}), innovativeness(X_{13}) and emotional intelligence(X_{18}) are positively and significantly associated with the dependent variable, physical resilience index(Y_4).On the other hand, the variable cropping intensity(X_6) is negatively and significantly associated with the dependent variable, physical resilience index(Y_4).
- ✓ The variable extension contact(X_{10}), training exposure(X_{12}), operational land holding(X_{05}) and economic motivation(X_{14}) are positively and significantly contributing towards characterizing the predicted variable, physical resilience index.
- ✓ The R^2 value being 0.334, it is to infer that the eighteen predictor variables put together have explained 33.40% variation embedded with the predicted variable physical resilience index.
- ✓ The variables namely family education status(X_2), operational land holding(X_5), annual income(X_7), annual expenditure(X_8), social participation(X_9), extension contact(X_{10}), mass media exposure(X_{11}), training exposure(X_{12}), innovativeness(X_{13}), economic motivation(X_{14}), scientific orientation(X_{15}), management orientation(X_{16}), risk bearing

ability(X_{17}) and emotional intelligence(X_{18}) are positively and significantly associated with the dependent variable, Farmer resilience index (Y).On the other hand, the variable family size and cropping intensity(X_6) are negatively and significantly associated with the dependent variable, Farmer resilience index (Y).

- ✓ The variable Annual expenditure(X_{08}), scientific orientation(X_{15}) and extension contact(X_{10}) are positively and significantly contributing towards characterizing the predicted variable, farmer resilience index.
- ✓ The R^2 value being 0.422, it is to infer that the eighteen predictor variables put together have explained 42.20% variation embedded with the predicted variable farmer resilience index.
- ✓ There is no significant difference among the villages with respect to Farmer Resilience Index
- ✓ The variables are clubbed into four factors namely Psycho-economic competency factor, Personal expertise factor, Capacity building factor and Educational exposure factor.
- ✓ It is found from neural network analysis that farming experience (X_3) has the maximum level of influence followed by annual expenditure(X_8), mass media exposure(X_{11}) explaining the predicted variable ,Farmer resilience index.
- ✓ The first three farmers' preferences of agricultural extension needs on the thematic area of agricultural inputs under up to date Information dimension are flood and drought resistant varieties, and disease and pest resistant varieties; HYVs and hybrids seeds; and prices and subsidy schemes of Govt. for machineries, equipment and implements
- ✓ The first three farmers' preferences of agricultural extension needs on the thematic area of agricultural finance under up to date Information dimension are amount of subsidies given by Govt.; Pradhan Mantri Fasal Bima Yojana (PMFBY) and agencies providing insurance services in agricultural sector.
- ✓ The first three farmers' preferences of agricultural extension needs on the thematic area of agricultural production under up to date Information dimension are preparedness against natural calamities; choosing the pesticide according to the pest incidence and soil testing service
- ✓ The first three farmers' preferences of agricultural extension needs on the thematic area of Post-harvest management under up to date Information dimensions are subsidy or

credit schemes subsidy or credit schemes for storage; latest machines and technologies for grading and latest processing technologies for farm production.

- ✓ The first two farmers' preferences of agricultural extension needs on the thematic area of marketing under up to date Information dimension are, which products have a high demand in the market and current prices of agricultural produce
- ✓ The first three farmers' preferences of agricultural extension needs on the thematic area of livelihood diversification under up to date Information dimension are ancillary occupation; integrated farming system and how and when one should change the farm enterprise combination
- ✓ The first three farmers' preferences of agricultural extension needs on the thematic area of agricultural inputs under Training & Demonstration dimension are efficient use of seeds, fertilizer and efficient measure of plant protection.
- ✓ Farmer respondents mostly prefer the Training & Demonstration on crop insurance (PMFBY) under the thematic area of agricultural finance.
- ✓ The first two farmers' preferences of agricultural extension needs on the thematic area of agricultural production under Training & Demonstration dimension are flood and drought resistant crop varieties, and preparedness/crop contingency planning against natural calamities or disaster/hazards.
- ✓ The first two farmers' preferences of agricultural extension needs on the thematic area of post harvest management under Training & Demonstration dimension are Packaging and Storing
- ✓ The first two farmers' preferences of agricultural extension needs on the thematic area of livelihoods diversification under Training & Demonstration dimension are Entrepreneurship Development and Custom Hiring Centre
- ✓ The first three farmers' preferences of agricultural extension needs on the thematic area of agricultural inputs under mitigation strategy dimension are cultivating flood tolerant rice varieties, practicing in-situ rain water harvesting for moisture conservation (mulching), and practicing mixed cropping and inter cropping.
- ✓ The first three farmers' preferences of agricultural extension needs on the thematic area of institutional building under mitigation strategy dimension are establishing custom hiring centre, regulated market and seed bank.

- ✓ The first three farmers' respondents' socio-economic challenges associated with agricultural extension needs and disaster resilience are lack of exposure to agricultural development; inadequate access to training and demonstration and lack of crop insurance facilities
- ✓ The first three farmers' respondents' technical challenges associated with agricultural extension needs and disaster resilience are the unpredictability nature of disaster events; Various type/natures of disasters and their changing magnitude levels and changing weather pattern
- ✓ The first three farmers' physical and infrastructural challenges associated with agricultural extension needs and disaster resilience are lack of irrigation facilities, non availability of cold storage facilities and training Institutes nearby
- ✓ The first three farmers' organizational/institutional challenges associated with agricultural extension needs and disaster resilience are lack of agricultural shop nearby, lack of custom hiring centre and lack of Seed Bank.
- ✓ FCM states that components income, education, knowledge of crop/ farm diversification, operational land holding and training exposure have significant impact in enhancing farmers' disaster resilience.
- ✓ A paradigm of adaptive capacity towards disaster has been developed through social, economic, technical and physical dimensions of resilience enhanced by agricultural extension information, training and demonstration, and mitigation strategy. It clearly dictates the policies and programmes and farmers' resilience development outcomes that create a definite structure of interaction.
- ✓ A paradigm of farmers' disaster resilience has been developed by incorporating their socio-personal, economic, psychological and communication characteristics. It clearly dictates the policies and programmes and farmers' resilience development outcomes that create a cobweb structure of interaction.

7.2 Conclusion and Recommendation

In the present scenario of technological advancement in agriculture, the farm disaster is considered one of the most serious environmental threats facing the farming community worldwide. Almost 2.5 billion people worldwide depend on agriculture for their livelihoods and agriculture is highly vulnerable to the impacts of recurrent disasters. The agriculture sector faces

varying disaster impacts which mainly worsen production condition and adversely affects the economies of agriculture-based economic countries. In recent years multiple disasters have imposed devastating consequences on agriculture, food security and the livelihoods of millions of farmers. Staple food production in many agriculture-based countries remains largely rain-fed and uninsured against the large fluctuations caused by weather and climatic variability. The agriculture sector often faces multipronged and long-lasting consequences of disasters, such as the deterioration of soil and animal health, contamination of aquaculture facilities, loss of harvests, outbreaks of disease or destruction of irrigation systems and other infrastructure. Such impacts can be particularly detrimental in underdeveloped or developing countries, where agriculture tends to be the economic backbone, often contributing up to 20–30 percent of national GDP and employment. Over time the frequency and intensity of natural disasters are increasing across the globe and the agricultural production base is being damaged and thereby many farmers are losing their livelihoods or being marginalized. Natural disasters mainly floods, draughts, cyclones and hailstorms are posing a threat to food and livelihood security for millions of people. Inadequate risk mitigation support and the near absence of nonfarm employment with recurrent natural disasters make farmers' lives complex and difficult. Terms like crop, livestock, and fishery insurance are still new for Indian farmers. Such a scenario has the potential danger of weakening the capacity of the farmers to cope with these eventualities and to be able to meet the food needs of an ever-increasing population. In this connection, agricultural extension may offer an opportunity for strengthening the resilience of farming communities against farm disasters by increasing their access to various agricultural information, knowledge, skills and inputs. Agricultural extension may be able to play a crucial role in promoting agricultural development and improving the resilience of farmers to absorb and bounce back from the impact of any crisis situation. Agricultural extension provides critical and technical support services for farming communities to meet the new challenges such as floods, drought, cyclones etc confronting agriculture. Although there is well well-defined agricultural extension service in a country like India, it is observed that agricultural extension systems or machinery face the daunting task of providing the required service to meet the extension demand before, during and after the disaster strike in preparedness, mitigation and rehabilitation stage of the disaster management cycle. Many farmers developed their own strategies and followed indigenous disaster reduction practices to minimize the effect of farm disaster on production but failed because of recurrent

and unpredictable occurrences of disasters with changing magnitude or intensity levels. And thereby farmers are losing their resilience against various types of natural farm disasters. Despite the need for timely and well-targeted information on disaster risks, there are currently a number of gaps and challenges in providing disaster-mitigating information to farmers. Effective and timely provision of agricultural extension plays a crucial role in farm disaster management. In such a scenario, assessing farmers' disaster resilience is important for policymakers, communities and aid providers to incorporate evidence-based technologies in agricultural extension systems. Assessment of the agricultural extension needs of disaster-affected farmers is also crucial to develop a holistic extension plan and policies ensuring resilience; food and livelihood security for the disaster-ravaged farming community of the country. The study holds good by identifying different factors associated with farmers' disaster resilience for addressing the global issue in local situations. The frontline outcomes of the research in a nutshell may be delineated as:

- Farmer Resilience Index is determined through four dimensions namely economic resilience index, social resilience index, technical resilience index and physical resilience index with each dimension having individual variables.
- Farmer resilience index varies from farmer to farmer
- Economic resilience index mostly depends upon different socio-personal, socio-economic, socio-psychological and extension-communication attributes of the farmers.
- Social resilience index mostly depends upon different socio-personal, socio-economic, socio-psychological and extension-communication attributes of the farmers.
- Technical resilience index is mostly depending upon different socio-personal, socio-economic, socio-psychological and extension-communication attributes of the farmers.
- Physical resilience index is mostly depending upon different socio-personal, socio-economic, socio-psychological and extension-communication attributes of the farmers.
- Farmer resilience index mostly depends upon different socio-personal, socio-economic, socio-psychological and extension-communication attributes of the farmers.
- Farmers' importance of agricultural extension needs varies from farmer to farmer on the different thematic areas under different extension need dimensions for their resilience development against farm disasters.

- ❖ Farmers' prioritization of challenges associated with agricultural extension needs and disaster resilience varies from farmer to farmer

On the basis of the result found in the present study the following suggestive recommendations are made for future policy implications which are mostly economic, social, technical and physical aspects:

- ✓ As the majority of the farmer respondents belong to medium to low level of economic resilience index, a massive Govt. policy and programme should be framed for increasing opportunity for diversity of household income sources, off-season income, household and farm assets creation, access to the credit and crop insurance of disaster affected farming communities.
- ✓ Since more than half of the farmer respondents belong to the medium to low level of the social resilience index, Govt. should take proper policy initiatives for increasing farmer-based organization; awareness programmes on farm disasters; access to extension and advisory service; basic community service and availability of social safety net in the disaster affected areas. The government should ensure that the benefits of flagship social welfare programmes reach the most disaster-vulnerable sections of society.
- ✓ As the vast majority of the farmer respondents belong to medium to low level of technical resilience index, a massive and farmer-friendly agricultural transfer of technologies programme should be developed to increase farmers' knowledge on flood and drought-resistant varieties, early maturing varieties, intercropping, relay cropping, integrated farming system, unconventional production practices, modern plant protection technologies and access to daily weather data, flood/drought/storm disaster warning in the disaster affected areas.
- ✓ As the majority of the farmer respondents belong to medium to low levels of physical resilience, Govt. should frame an appropriate policy to develop farm infrastructure such as drainage and irrigation systems; farm roads and electricity connection etc in the disaster-vulnerable areas
- ✓ It would be venturesome to expect the adoption of farm disaster resilient and mitigating agricultural technologies in such situations when the reach of the formal extension machinery is limited. It is therefore the need of the hour to put in place innovative,

responsive and dedicated extension machinery in disaster-vulnerable areas in order to ensure that such technologies are popularised and are adopted by the farmers.

- ✓ The results indicate that a low to medium level of social participation and emotional intelligence are prevalent. Social participation and emotional intelligence of the farmer are required to increase their negotiation and bargaining powers to ensure their rights and interests. To achieve this, small farmer groups in the form of SHGs/FIGs/CIGs/FPOs etc. can be formed with capacity building and handholding support.
- ✓ A holistic and massive farmer-friendly revamped agricultural extension system or farm disaster extension system should be evolved based on the farmers' needs and challenges, and covering all aspects of farm disaster management ensuring reach to all farmers of vulnerable areas.



FUTURE SCOPE OF RESEARCH

In the changing global scenario, natural disasters pose one of the most significant challenges to humankind because of their potentially catastrophic impacts and the unknown nature and uncertainty of their onset. Agriculture is both an area of human activity at risk from disaster as well as a driver of climate and environmental change. The increase in temperature and climatic variability impacts the system of food production and agricultural development. Climate change and agriculture have a two-way relationship wherein agriculture is one of the contributors to climate change parameters and at the same time, climate change in the form of hazards and disasters has also a significant impact on agriculture. To alleviate some of the complex challenges posed by natural disasters, agriculture has to become disaster resilient that is, sustainably increase agricultural productivity and profitability, adapt and build resilience to natural disasters. In short, agriculture systems have to become more efficient by using less land, water and inputs to produce more food sustainably, and along with the farmers, who manage them, be more resilient to changes, threats and shocks. Extension services were traditionally conceived as the mechanism to put research-based knowledge into use with a strong focus on increasing agricultural production. In response to the changing nature of agriculture and farmers' needs, the focus of agricultural extension in the past three decades has shifted away from transferring skills, technologies and knowledge related to the production of crops, from research to farmers, to developing technologies with farmers and catalyzing and facilitating innovation processes for combating the farm disaster. Extension and advisory services may offer an opportunity for strengthening the resilience of rural and farming communities/households by increasing their access to agricultural inputs, knowledge and skills.

In such a resilient research climate, the present study has been methodically carried out to explore the farmers' disaster resilience and derive definite extension strategies to avert the impact of the disaster in agriculture to ensure sustainable production and income. Though the present study reaches its aim with a definite conclusion still there is some future scope of this research study that may be delineated as:

- A similar type of research problem may be constructed to explore the areas of impact of the disaster in agriculture
- The present study may be conducted in larger geographical areas to test the genuinity and consistency of the present findings and also to arrive at some generalization of the findings.

- In the present study, four dimensions such as economic, social, technical and physical are utilized to explain the farmer resilience index. It is therefore suggested to include the environmental dimension in future research in order to get a more comprehensive viewpoint of the farmer resilience index
- Additional personal, socio-economic, communication, situational and psychological variables can be brought under the ambit of future research to better explain the domain of the farmer resilience index. This may include variables like self-orientation, achievement motivation, change proneness, level of aspiration, indebtedness, access to markets, technology utilization, pattern of migration etc.
- The similar type of studies may be conducted to assess the role of different extension advisory organizations and institutions in enhancing farmers' resilience against various types of disasters.
- The more similar types of research are needed to derive concrete extension approaches for enhancing farmers' disaster resilience to ensure sustainable agricultural production.
- The similar research study may be conducted to isolate the technological and extension gap in practice related to farmers' disaster resilience.
- The research study may be conducted to analyse the impact of farm disasters through community-based farmers' organizations.
- In order to further extrapolate the nature and extent of predictor variables with the farmer resilience index, it may be suggested to utilize more rigorous statistical analytical tools such as path analysis, canonical correlation analysis etc. This will give a better insight into the manner in which resilience is connected to or influenced by different variables.



BIBLIOGRAPHY

Adger, W.N., (2000). Social and ecological resilience: are they related? Progress in Human Geography, **24**(3) 347–364.

Adger, W. N. (2006). Vulnerability. *Global environmental change*, **16**(3), 268-281.

Adhiguru, P., Birthal, P. S., & Kumar, B. G. (2009).Strengthening Pluralistic Agricultural Information Delivery Systems in India.*Agricultural Economics Research Review*, **22**(1), 71-79.

Adio, E. O., Abu, Y., Sheriff, K., &Nansoh, S. (2016). Use of Agricultural Information Sources and Services by Farmers for Improve Productivity in Kwara State. *Library Philosophy and Practice (e-journal)*, 1456.

Afroz, S., & Singh, R. (2018).Farmers' Attitude towards Digital Green Participatory videos for Agricultural Information Dissemination.*Journal of Community Mobilizationand Sustainable Development,***13**(2), 239-244.

Alam, GMM. Alam K, Mushtaq., S, Filho WL. (2018). How do Climate Change and associated Hazards Impact onthe Resilience of Riparian Rural Communities in Bangladesh? *Policy Implications for Livelihood Development .Environ Sci Policy,* 84:7–18.https://doi.org/10.1016/j.envsci.

Al-Zahrani, K. H., Khan, A. Q., Baig, M. B., &Mubushar, M. (2019).Perceptions of Wheat Farmers toward Agricultural Extension Services for Realizing Sustainable Biological Yields.*Saudi Journal of Biological Sciences*, **26**(7), 1503-1508.

Anand, R. Rathod.(2007). A Study on Sustainable Livelihoods of Lambani Farmers in Hyderabad, Karnataka, M.Sc. (Agri.) Thesis (Unpub.), Univ. Agric. Sci., Dharwad.

Anand, R.N. (2007). A Study on Sustainable Livelihoods of Lambani Farmers in Hyderabad, Andhra Pradesh.M.Sc. (Agri.) Thesis.University of Agricultural Sciences, Dharwad.

Antwi-Agyei, P., Dougill, A. J., & Stringer, L. C. (2013). Barriers to Climate Change Adaptation in Sub-Saharan Africa: Evidence from Northeast Ghana & Systematic Literature Review. *Centre for climate change economics and policy working paper*, 154.

Anonymous.(2009). Live Better with the Flood – An Approach for Sustainable Livelihood Security in District Dhemaji, Assam: A Case Study. National Agriculture Innovation Project. Action For Food Production (AFPRO).

Anonymous.(1999). Bhowmic *et. al*., A Report on Farming System In Assam, Department Of Agricultural Economics, Assam Agricultural University, Jorhat.

Anonymous.(2012). Das, Kalyan and South Asian Network for Development and Environmental Economics Farm Productivity Loss Due to Flood-Induced Sand Deposition: A Study in Dhemaji, India. *Kathmandu South Asian Network for Development and Environmental Economics*, SANDEE Working Papers, 1893-1891.

Asian Development Bank. (2013). Investing in Resilience: Ensuring a Disaster-Resistant Future; Asian Development Bank: Mandaluyong City, Philippines,.

Ali, M., Man, N., Abd Latif, I., Muharam, F. M., & Zobidah Omar, S. (2018). The Use of Informationand Communication Technologies in Agricultural Risk Management by the Agricultural Extension Services in Malaysia.*International Journal of Agriculture, Environment and Food Sciences*, **2**(1): 29-35. https://doi.org/10.31015/jaefs.18005

Alinovi, L., Mane, E., &Romano, D. (2008). Towards the measurement of household Resilience to Food Insecurity: applying a model to Palestinian household data. In *Deriving food security informationfrom national household budget surveys. Experiences, achievement,* 137-152.

Alinovi, L., D'errico, M., Mane, E., & Romano, D. (2010). Livelihoods strategies and household Resilience to Food Insecurity: An Empirical Analysis to Kenya. *European Report on Development*, **1**(1), 1-52.

Allison, E. H., &Horemans, B. (2006).Putting the Principles oftheSustainable Livelihoods approach into Fisheries Development Policy and Practice. *Marine policy*, **30**(6), 757-766.

Alshehri, S. A., Rezgui, Y., & Li, H. (2015).Delphi-based consensus study into a framework ofCommunity Resilience to Disaster. *Natural Hazards*, **75**, 2221-2245.

Aram, I. A., Murugan, G. S., Raj, S. A., Nambi, A. A., & Anabel, N. J. (2018). Mobile Extension in Enhancing the Livelihood of Farmers in India.*International Journal of E-Politi*cs, **9**(1), 48-58. Retrieved fromhttps://doi.org/10.4018/IJEP.2018010104.

Ayeb-Karlsson, S., Van der Geest, K., Ahmed, I., Huq, S., & Warner, K. (2016).A people-centred perspective on Climate Change, Environmental Stress, and Livelihood Resilience in Bangladesh. *Sustainability Science*, **11**, 679-694.

Babu, S. C., Glendenning, C. J., Okyere, K. A., &Govindarajan, S. K. (2011). Farmers' Information Needs and Search Behaviors- A Case Study in Tamil Nadu, India, IFPRI Discussion Paper 01165, *International Food Policy Research Institute, Washington, DC, USA*.

Babu, S. C., Joshi, P. K., Glendenning, C. J., Okyere, K. A., &Sulaiman, V. R. (2013). The State of Agricultural Extension Reforms in India: Strategic Priorities and Policy Options. *Agricultural Economics Research Review*, **26(**2), 173-184.

Bachhav, N. B. (2012). InformationNeeds ofThe Rural Farmers: A study from Maharashtra, India: A Survey. *Library Philosophy and Practice (e-journal)*, Retrieved fromhttp://digitalcommons.unl.edu/libphilprac/866.

Bahadur, A. V., Ibrahim, M., & Tanner, T. (2013).Characterizing Resilience: Unpacking the concept for tackling Climate Change and Development. *Climate and Development*, **5**(1), 55-65.

Balkrishna, B. B., &Wagh, V. W. (2014).Role of Information Technology in Agriculture Marketing and its Scope in Pune District.*International Journal of Management, IT and Engineering,***4**(8), 199-210.

Barnes, A. P., & Toma, L. (2012).A typology ofDairy Farmer Perceptions towards *Climate Change. Climatic Change*, **112**, 507-522.

Barman, S., Pathak, K.and Pathak, P.K. (2013).Training Need of Tribal Farmers in Rape Seed Production Technology of Upper Brahmaputra Valley Zone of Assam.*Journal of Academic andIndustrial Research*.**1**(11).

Barrett, C. P., Reardon, T. and Webb, P. (2001). Non-Farm Income Diversificationand Household Livelihood Strategies in Rural Africa: Concepts, Dynamics, and Policy Implications. Retrieved From Http:// Www. Researchgate.Net/Publication/47/On 3rd September, 2013 At 7.15 Pm.

Barua,P, & Rahman, S. H. (2020).Resilience of Agriculture Farmers for Crop Productionin responses to Climate Change Impact on South-Eastern Coast of Bangladesh. *Environment and Ecosystem Science*, **4**(1), 28-37.

Benard, R., Dulle, F., & Ngalapa, H. (2014). Assessment of Information Needs of Rice Farmers in Tanzania; A Case Study of Kilombero District, Morogoro. *Library Philosophy and Practice (e-journal)*, **1071**, 1-34.

Bergstrand, K., Mayer, B., Brumback, B., & Zhang, Y. (2015). Assessing the Relationship Between Social Vulnerability and Community Resilience to Hazards. *Social Indicators Research*, **122**, 391-409.

Birner, R., Davis, K., Pender, J., Nkonya, E., Anandajayasekeram, P., Ekboir, J., & Cohen, M. (2009).FromBest Practice to Best Fit: A Framework for Designing and Analyzing Pluralistic Agricultural Advisory Services worldwide. *Journal of Agricultural Educationand Extension*, **15**(4), 341-355.

Borosa, M. (2016). A Study onthe Livelihood Options and Attitude of Tribal Youth towards Farming in Assam. Unpublished M.Sc.(Agri) Thesis. Deptt. of Extension Education. Assam Agricultural University, Jorhat.

Boz, I., & Ozcatalbas, O. (2010). Determining Information Sources used by Crop Producers: A Case Study ofGaziantep Province in Turkey. *African Journal of Agricultural Research*, **5**(10), 980-987.

Brown, K. (2015).Resilience, development and global change. *Routledge, London, UK*, 1–228.

Burman, R. R. (2008). ICT Led Agricultural Extension in India: Issues and Opportunities. *Journal of Global Communication*, **1**(1), 68-75.

Carpenter, S., Walker, B., Anderies, J. M., & Abel, N. (2001). FromMetaphor to Measurement: Resilience of What to What? *Ecosystems*, **4**, 765-781.

Chand, R., Saxena, R., & Rana, S. (2015). Estimates and Analysis of Farm Income in India: 1983-84 to 2011-12, *Economic and Political Weekly*, **1** (22), 139-145.

Chanana A. (2016). Economic Condition of Farmers in India.*International Journal of Commerce and Management Research*, ***2***(5), 43-44.

Chand, R. (2017). Doubling Farmers' Income- Rationale, Strategy, Prospects and Action Plan. NITI Policy Paper No. 1. *National Institute for Transforming India, Government of India, New Delhi.*

Chatterjee, S., &Nath, A. (2015).TheRole of Information and CommunicationTechnologies in Rural Development in India.*International Journal of Emerging Technology and Advanced Engineering,**5***(3), 251-259.

Chen, Y., & Lu, Y. (2019). Factors Influencing the Information Needs and Information Access Channels of Farmers: An Empirical Study in Guangdong, China. *Journal of Information Science*, **46**(1), 3-22.

Chisty, M. A., Rahman, M., Khan, N. A., &Dola, S. E. A. (2022). Assessing Community Disaster Resilience in Flood-Prone Areas of Bangladesh: From A Gender Lens. *Water*, **14**(1), 40.

Christian, B. M. (2001). A Study on Extent of Adoption of IPM Strategy by Cotton Growers of Vadodara District of Gujarat State.Unpublished M.Sc. (Agri.) Thesis, Gujarat Agriculture University, Anand, India.

Choudhary, G. C. M. (1997). A Study on Krishi Vigyan Kendra (KVK) in Chittoor District of Andhra Pradesh.M.Sc (Agri) Thesis. Acharya N.G. Ranga Agricultural University, Hyderabad.

Cinner, J. E., & Barnes, M. L. (2019).Social Dimensions of Resilience in Social-Ecological Systems. *One Earth*, **1**(1), 51-56.

Coetzee, C., Van Niekerk, D., &Raju, E. (2016). Disaster Resilience and Complex Adaptive Systems Theory: Finding Common Grounds for Risk Reduction. *Disaster Preventionand Management*.**25**, 196–211.

Cox, R. S., & Hamlen, M. (2015).Community Disaster Resilience andthe Rural Resilience Index. *American Behavioral Scientist*, **59**(2), 220-237.

Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., & Webb, J. (2008). A Place-Based Model for Understanding Community Resilience to Natural Disasters. *Global Environmental Change*, **18**(4), 598-606.

Das, B. (2014). ICTs Adoption for Accessing Agricultural Information: Evidence from Indian Agriculture. *Agricultural Economics Research Review*, **27**(2), 199-208.

DFID (2011). Defining Disaster Resilience: A DFID Approach Paper; Department for International Development: London, UK.

Deressa, T. T., Hassan, R. M., & Ringler, C. (2011).Perceptionofand Adaptation to Climate Change by Farmers in theNile Basin ofEthiopia. *The Journal of Agricultural Science*, **149**(1), 23-31.

Doley, P. (2015). A Study on the Extent of Livelihood Security of the Mising Farmers in Lakhimpur District of Assam.M.Sc. (Agri) Thesis. Assam Agricultural University, Jorhat.

Dutta, J. K. (1998). A Study on the Level of Commercialization of the Farmers of Kamrup District, Assam.M.Sc. (Agri) Thesis. Assam Agricultural University, Jorhat, Assam.

Eckstein, D., Künzel, V., Schäfer, L., &Winges, M. (2019).Global Climate Risk Index 2020. *Bonn: Germanwatch*.

Feder, G., &Umali, D. L. (1993).The Adoptionof Agricultural Innovations: A Review. *Technological Forecasting and Social Change*, **43**(3-4), 215-239.

Ferroni, M., & Zhou, Y. (2012). Achievements and Challenges in Agricultural Extension in India. *Global Journal of Emerging Market Economies*, **4**(3), 319-346.

Folke, C., Colding, J., & Berkes, F. (2003). Building Resilience and Adaptive Capacity in Social-Ecological Systems. In F. Berkes,J. Colding, & C. Folke (Eds.) Navigating social-ecological systems: Building resilience for complexity and change (pp. 352–387). Cambridge: Cambridge University Press

Ganesan, M., Karthikeyan, K., Prashant, S., &Umadikar, J. (2013). Use of Mobile Multimedia Agricultural Advisory Systems by Indian Farmers: Results of aSurvey. *Journal ofAgricultural ExtensionandRural Development*, **5**(4), 89-99. https://doi.org/10.5897/JAERD13.0466

Gwimbi, P. (2009). CottonFarmers' Vulnerability to Climate Change in Gokwe District (Zimbabwe): Impact and Influencing Factors. *JAMBA: Journal of Disaster risk studies*, **2**(2), 81-92.

Haldar, S., Misra, S., Pal, S., Basu, D., &Goswami, R. (2016). Understanding Agricultural Information Networks in West Bengal, India.*Indian Research Journal of Extension Education*, **16**(1), 25-34.

Halakatti, S.V., Gowda, D. S. M., & Natikar K. V. (2010). Role of Mass Media In Transfer Of Agricultural Technologies. *Research Journal of Agricultural Sciences*, **1**(3), 290-291.

Hanumanaikar, R. H., Manjunath, L., &Natikar, K. V. (2011).Reading Behavior of Farmers - Farm Magazines.*Karnataka J. Agric. Sci*., **24**(4): 471-473.

Haque, M.M. (2005). Information Needs of Field Management Committee (FMC) Members on Winter Vegetables Production Technology in Dhubri District of Assam. Unpublished M.Sc. (Agri) Thesis, Assam Agricultural University, Jorhat.

Henry G.A.(2011) Farmers' perceptionand adaptation to climate change: A willingness to pay analysis. *J. Sustainable Development in Africa*, **13** (5).

Hughes, K., Fuller, R., & Bushell, H. (2013).A Multidimensional Approach to Measuring Resilience.Oxfam UK Working Paper.http://policy-practice.oxfam.org.uk/publications/a-multidimensional-approach-tomeasuring-resilience-302641

Ifeanyi-Obi, C. C., & Issa, F. O. (2013). Barriers faced by Cassava Farmers in Adapting to Climate Change in Oron Agricultural Zone of AkwaIbom State. *IORS Journal of Agriculture and Veterinary Science*, **4**(6), 19-26.

Igodan, C. O., Ohaji, P. E., & Ekpere, J. A. (1988). Factors Associated with the Adoptionof Recommended Practices for Maize Production in the Kainji Lake Basin of Nigeria. *Agricultural Administrationand Extension*, **29**(2), 149-156.

Intergovernmental Panel on Climate Change. (2007). Climate change 2007: Appendix to synthesis report. In A. P. M.Baede, P. van der Linden, & A. Verbruggen (Eds.), Synthesis report (pp. 76–89). Geneva: Author.

Jaisridhar, P., Kumar, R. S., &Sangeetha, S. (2012). E-Sagu: A Web Based Agricultural Expert Advice Dissemination System from Informationand Communication Perspective. *International Journal of Food, Agriculture and Veterinary Sciences*, **2**(3), 99-104.

Jayadas, A., &Ambujam, N. K. (2021).Research and Design of a Farmer Resilience Index in Coastal Farming Communities of Tamil Nadu, India. *Journal of Water and Climate Change*, **12**(7), 3143-3158.

Joerin, J., Shaw, R., Takeuchi, Y., & Krishnamurthy, R. (2014).The Adoptionof a Climate Disaster Resilience Index in Chennai, India. *Disasters*, **38**(3), 540-561.

Joseph, J. K., Anand, D., Prajeesh, P., Zacharias, A., Varghese, A. G., Pradeepkumar, A. P., & Baiju, K. R. (2020). Community Resilience Mechanism in an Unexpected Extreme Weather Event: An Analysis oftheKerala Floods of 2018, India. *International Journal of Disaster Risk Reduction*, **49**, 101741.

Kakoty, M. (2013).Livelihood Opportunities of Rural Youths Studying in Dhemaji District of Assam.M.Sc (Agri) Thesis. Assam Agricultural University, Jorhat.

Kalel, K. N. (2014). Economics of Production and Marketing of Soybean in Kolhapur District. M.Sc. Thesis, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra.

Kalita, D (2016). The Information Needs and Information Seeking Behaviour of Farmers of Nalbari District of Assam With Reference to Climate Change Adaptation. M.Sc. thesis submitted to Assam Agricultural University, Jorhat.

Kamani K C, Ghodasara Y R, Soni N V, & Parsaniya, A. (2016). Empowering Indian Agriculture with WhatsApp- A Positive Step Towards Digital India. *International Journal of Agriculture Sciences*, **8**(13), 1210-1212.

Karn, A., &Ghosh, S. (2018). Effectiveness of Farmers' Information Sources in Bihar.*Journal of Community MobilizationAnd Sustainable Development*, **13**(2), 367373.

Kebede, Y., Gunjal, K., & Coffin, G. (1990).Adoptionof New Technologies in Ethiopian Agriculture: The Case of Tegulet-Bulga District, Shoa Province. *Agricultural economics*, **4**(1), 27-43.

Khatun, D. and Roy, B.C. (2012). Rural Livelihood Diversificationin West Bengal: Determinants and Constraints. *Agricultural Economics Research Review.***25** (1):115-124.

Komba, C., & Muchapondwa, E. (2012).Adaptation to Climate Change by Smallholder Farmers in Tanzania. *Economic Research Southern Africa (ERSA) working paper*, **299**(5).

Kotzee, I., & Reyers, B. (2016).Piloting a Social-Ecological Index for Measuring Flood Resilience: A Composite Index Approach. *Ecological indicators*, **60**, 45-53.

Kumar, S., Sangeetha, V., Singh, P., Burman, R. R., Bhowmik, A., & Kumar, S. A. (2017). Constraints Faced by Farmers in Utilizing Rice Related Information Through Rice Knowledge Management Portal (RKMP). *Indian Journal of Extension Education*, **53**(1), 84-89.

Kumbhare, N. V., Padaria, R. N., Singh, P., Kumar, A., & Sarkar, S. (2015). Community Radio: Preferences, Opinion and Behaviour of Farmers. *Indian Journal of Extension Education*, **51**(3-4), 20-24.

Lahiri, B., & Mukhopadhyay S. D. (2012). Content Analysis of Farm Information Communicated Through Selected Radio Programme. *Indian Research Journal of Extension Education*, **12**(1), 29-35.

Lalitha, M., (2016). A Study on Impact of Climate Change on Agro Bio-Diversity Among Dry Land Farmers in Chickballapur District of Karnataka State M.Sc. (Agri) Thesis (Unpub.), Univ. Agric. Sci., Bangalore.

Lambin, E. F. (2005). Conditions for Sustainability of Human–Environment Systems: Information, Motivation, and Capacity. *Global Environmental Change*, **3**(15), 177-180.

Laska, S. (2012). Dimensions of Resiliency: Essential Resiliency, Exceptional Recovery and Scale. *International journal of critical infrastructures*, **8**(1), 47-62.

Levin, S. A. (1998). Ecosystems and the Biosphere as Complex Adaptive Systems. *Ecosystems*, **1**, 431-436.

Lwin, K. K., Pal, I., Shrestha, S., & Warnitchai, P. (2020). Assessing Social Resilience of Flood-Vulnerable Communities in Ayeyarwady Delta, Myanmar. *International Journal of Disaster Risk Reduction*, **51**, 101745.

Maddison, D.(2007). The Perception and Adaptation to Climate Change in Africa.World Bank Publications, 4308.

Maddison, D. (2007). ThePerceptionand Adaptationto Climate Change in Africa. (CEEPA) Centre ForEnvironmental Economics andPolicy in Africa. Pretoria, South Africa: Univ. ofPretoria. Discussion Paper No. 10.

Mahanta, G (2018). A Study on Information Need and Information Seeking Behaviour of Small Tea Growers in Relationto Organic Tea Cultivationin North Blank Plains Zone ofAssamM.Sc. Thesis Submitted to Assam Agricultural University, Jorhat.

Menong, J. M., Mabe, L. K., & Oladele, O. I. (2013). Analysis of Extension Needs of Commercial Farmers in North-West Province, South Africa. *Journal of Human Ecology*, **44**(2), 139-147.

Meuwissen, M. P., Feindt, P. H., Spiegel, A., Termeer, C. J., Mathijs, E., De Mey, Y.,& Reidsma, P. (2019). A Framework To Assess The Resilience Of Farming Systems. *Agricultural Systems*, **176**, 102656.

Mittal, S., & Mehar, M. (2013). Agricultural Information Networks, Information Needs And Risk Management Strategies: A Survey Of Farmers In Indo-Gangetic Plains of India. Socio-Economics Working Paper 10.Mexico, D.F.: CIMMYT

Mittal, S. (2012).Modern ICT for Agricultural Development and Risk Management in Smallholder Agriculture in India.CIMMYT.Socioeconomics Working Paper 3. Mexico, D.F.: CIMMYT.

Mittal S., Gandhi S., & Tripathi G. (2010). Socio-Economic Impact of Mobile Phones onIndian Agriculture, Working Paper No. 246, Indian Council ForResearch onInternational Economic Relations.

Mittal, S. (2012).Modern ICT for Agricultural Development andRisk Management in Smallholder Agriculture in India.CIMMYT.Socioeconomics Working Paper 3.Mexico, D.F.: CIMMYT.

Mittal, S., & Mehar, M. (2012). How Mobile Phones Contribute to Growth of Small Farmers? Evidence From India. *Quarterly Journal ofInternational Agriculture*, **51** (3), 227-244.

Mohapatra, A.S. and Sahu, U.P. (2012).A Study of Socio-Economic and Entrepreneurial Characteristics of Tribals of Mayurbhanj District in Sabai Grass Enterprise. *International Journal of Management in Education*.**2** (5).

Mtega, W. P., &Benard, R. (2013).TheState of Rural Informationand Communication Services in Tanzania: A Meta-Analysis. *Journal ofInformationandCommunication Technology Research*, **3**(2), 64-73.

Murthy, M. A., Naghabhushanam, K., & Gowda, N. S. (2019).Climate Resilience Management Level among Farmers in Eastern Dry Zone ofKarnataka. *Journal of Pharmacognosy and Phytochemistry*, **8**(5), 1671-1676.

Naberia, S., Gautam, U. S., &Gupta, A. K. (2011).Socio-Economic Factors Influencing Adoptionof Low-Cost Agricultural Technologies.*Indian Journal ofExtension Education*, **47**(3-4), 115-119.

Natikar, K.V. (2001). Attitude and Use of Farm Journals by the Subscriber Farmers andtheir Profile - A Critical Analysis. Ph.D. Thesis. University of Agricultural Sciences, Dharwad.

Nera, E., Paas, W., Reidsma, P., Paolini, G., Antonioli, F., &Severini, S. (2020). Assessing the Resilience and Sustainability of a Hazelnut Farming System in Central Italy with a Participatory Approach. *Sustainability*, **12**(1), 343.

Norris, P. E., &Batie, S. S. (1987). Virginia Farmers' Soil Conservation Decisions: An Application of Tobit Analysis. *Journal ofAgricultural AndApplied Economics*, **19**(1), 79-90.

Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008).Community Resilience As a Metaphor, Theory, Set ofCapacities,and Strategy for Disaster Readiness. *American Journal of Community Psychology*, **41**, 127-150.

NSSO (National Sample Survey Organization), (2005).SituationAssessment Survey of Farmers: Access to Modern Technology for Farming, 59th Round (JanuaryDecember 2003). Report No. 499(59/33/2). New Delhi: Ministry OfStatistics andProgramme Implementation

Ofuokus, A.U.(2011). Rural Farmers' Perceptionof Climate Change in Central Agricultural Zone of Delta State, Nigeria. *Indonesian J. Agric. Sci*., **12**(2): 63-69.

Ogboma, M. U. (2010). Access to Agricultural Information by Fish Farmers in Niger Delta RegionofNigeria.Library Philosophy andPractice (E-Journal). 424. Https://Digitalcommons.Unl.Edu/Libphilprac/424

Orencio, P. M., &Fujii, M. (2013). A Localized Disaster-Resilience Index to Assess Coastal Communities Based onan Analytic Hierarchy Process (AHP). *International Journal of Disaster Risk Reduction*, **3**, 62-75.

Ostadtaghizadeh, A., Ardalan, A., Paton, D., Khankeh, H., & Jabbari, H. (2016).Community Disaster Resilience: A Qualitative Study onIranian Concepts and Indicators. *Natural Hazards*, ***83***, 1843-1861.

Parimaladevi, S., Husain, A.S., & Bhaskaran, S. (2006). Determinants of the Effectiveness of Agriclinics and Agribusiness Centres Scheme in Kerala.*Journal of Tropical Agriculture,***44** (1-2), 91-93.

Parsons, M., Glavac, S., Hastings, P., Marshall, G., Mcgregor, J., Mcneill, J.,& Stayner, R. (2016). Top-Down Assessment of Disaster Resilience: A Conceptual Framework Using Coping and Adaptive Capacities. *International Journal of Disaster Risk Reduction*, **19**, 1-11.

Pawar, Y. B. (2010). Knowledge and Adoptionof Salt Affected Soil Reclamation Practices Followed by Farmers from Sangli District. M. Sc. Thesis, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra.

Pawar, Y. B. (2010). Knowledge and AdoptionOf Salt Affected Soil Reclamation Practices Followed By Farmers From Sangli District. M. Sc. Thesis, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra.

Patel, D.D. (2004). Information Needs of Cotton Growers. Unpublished M.Sc. (Agri) Thesis, Anand Agricultural University, Anand, Gujarat.

Patil, S. D., Shinde, S. B., & Kharde, P. B. (2016). Communication Mechanisms of Farmers for Acquisitionof Informationonfarm Mechanization. *Indian Research Journal of Extension Education,***16**(1), 80-84.

Pasteur, K. (2011). From Vulnerability To Resilience, A Framework For Analysis And Action To Build Community Resilience. Practical Action Publishing.

Phiri, A., Chipeta, G. T., & Chawinga, W. D. (2019). Information Behaviour of Rural Smallholder Farmers in Some Selected Developing Countries: A Literature Review. *Information Development*, **35**(5), 831-838.

Pingali, P., Alinovi, L., & Sutton, J. (2005). Food Security in Complex Emergencies: Enhancing Food System Resilience. *Disasters*, **29**, S5-S24

Pomp, M., & Burger, K. (1995). Innovationand Imitation: Adoptionof Cocoa by Indonesian Smallholders. *World Development*, **23**(3), 423-431.

Prathap, D. P., &Ponnusamy, K. A. (2006). Effectiveness ofFour Mass Media Channels onTheKnowledge Gain ofRural Women. *Journal ofInternational Agricultural andExtension Education*, **13**(1), 73-81. Available At SSRN: Https://Ssrn.Com/Abstract=1966865

Preethi,(2012). A Comparative Study on Knowledge and Perceptionof Agro-Met Advisory (AAS) Service Farmers andother Farmers towards Climate Change in Chickballapur District.M.Sc.(Agri) Thesis, (Unpub.), Univ. Agric. Sci., Bangalore.

Qasim, S., Qasim, M., Shrestha, R. P., Khan, A. N., Tun, K., &Ashraf, M. (2016).Community Resilience to Flood Hazards in Khyber Pukhthunkhwa Province of Pakistan. *International Journal ofDisaster Risk Reduction*, **18**, 100-106.

Rastogi, S., &Hasan, S. (2014).A Study on Communication Behaviour of Agricultural Input Users of Udham Singh Nagar District of Uttrakhand, India. *Journal of Applied and Natural Science*, **6**(1), 193-196.

Ratan, R.P. Singh, Topno, S.K., Topno, R.K., Singh, R.K., &Niva Bara (2005).Effect of Mass Media on Knowledge Gain.*Indian Journal ofExtension Education*, **41**(3&4), 80-81.

Raviya, P. B.(2017). Knowledge and Adoptionof Farmers about Cotton Production Practices Recommended by GAU AND JAU IN Junagadh District.M.Sc. (Agri.) Thesis (Unpublished), Junagadh Agricultural University, Junagadh.

Reddy Gurava, K. (1998).Knowledge of Agricultural Officers on Sustainable Agricultural Practices.M.Sc.(Agri) Thesis. Acharya N.G. Ranga Agricultural University, Hyderabad.

Reddy M. R. (1997). A Critical Analysis on Adoptionof Improved Practices of Diversified Farming Among Farmers in Mahaboobnagar District in Andhra Pradesh. M.Sc. (Ag.) Thesis, Acharya N.G. Ranga Agric.Uni. Hyderabad.

Saja, A. A., Goonetilleke, A., Teo, M., & Ziyath, A. M. (2019).A Critical Review of Social Resilience Assessment Frameworks in Disaster Management. *International Journal of Disaster Risk Reduction*, **35**, 101096.

Sangada, B. J., Jadav, N. B., &Ragul, M. G. (2016).Suggestive Model for Transfer of Technology, Constraints Faced in Getting Informationwith Respect to Groundnut Production Technology. International Journal of Agriculture Sciences, **8**(47), 1952-1954.

Sarker, M. N. I., Peng, Y., Yiran, C., &Shouse, R. C. (2020). Disaster resilience through big data: Way to environmental sustainability. *International Journal of Disaster Risk Reduction*, **51**, 101769.Https://Doi.Org/10.1016/J. Ijdrr.2020.101769.

Sasane, G. K., Khule, R. P., & Jagdale, U. D. (2010). Knowledge and Adoption of Sugarcane Management Practices by the Farmers. *Agriculture Update*, **5**(3&4), 391-393.

Schuck, E. C., Nganje, W., &Yantio, D. (2002).The Role of Land Tenure And Extension Educationin the Adoptionof Slash And Burn Agriculture. *Ecological Economics*, **43**(1), 61-70.

Shankara. M. H. (2010). A Study on Farmers Perception of Climate Change and Their Adaptations.M.Sc. (Agri.) Thesis (Unpub). Univ. Agric. Sci., Bangalore.

Shankara. M. H., (2010), A Study On Farmers Perception of Climate Change and Their Adaptations. M.Sc. (Agri.) Thesis (Unpub). Univ. Agric. Sci., Bangalore.

Sharma, A. K. (2014). Farmer's Satisfactionwith Information Sources and Services: A Study on Farmer's Opinion. *International Journal of Information Research*, **3**(4), 346-359.

Sharma, P. (2012). A Study on Livelihood Options and Opportunities of Inhabitants of the Tea Gardens in Jorhat District of Assam.M.Sc. (Agri.) Thesis. Assam Agricultural University, Jorhat.

Shashidhar, K. K. (2003). A Study on Socio-Economic Profile of Drip Irrigation Farmers in Shimoga and Davanagere Districts of Karnataka.M.Sc. (Agri.) Thesis.University of Agricultural Sciences, Dharwad.

Sherrieb, K., Norris, F. H., & Galea, S. (2010). Measuring Capacities for Community Resilience. *Social Indicators Research*, **99**, 227-247.

Singh M. (2012). Challenges and Opportunities for Sustainable Viability of Marginal and Small

Farmers in India.*Agricultural Situation in India*, 133-142.

Singh, M., & Singh, R. K. (2012). Constraints Perceived by Farmers in Communication Behaviour. *Indian Journal of Extension Education*, **48**(1-2), 52-55.

Singh, A. And Sadangi, B.N. (2012).Livelihood Patterns and Resource Base of Tribals in Koraput and Rayagada Districts of Odisha.*Indian Research Journal of Extension Education*.**I** (4), 307-312.

Singh, D. K., Gautam, U. S., Singh, M., & Singh, R. P. (2010). Media Exposure of The Farmers in Sagar District of Madhya Pradesh. *Indian Journal of Extension Education*, **46**(3-4), 26-30.

Spiegel, A., Slijper, T., de Mey, Y., Meuwissen, M. P., Poortvliet, P. M., Rommel, J, & Feindt, P. H. (2021).Resilience capacities as perceived by European farmers. *Agricultural Systems*, **193**, 103224.

Song, L., Li, Y., Long, R., Tong, L., Zhang, J., & Zhu, X. (2020). A Study onthe Assessment ofThe Resilience of Agricultural System Under Flood Disaster. In *IOP Conference Series: Earth and Environmental Science*, **525** (1).

Starasts, A. M. (2004). Battling theKnowledge Factor: A Study ofFarmers' Information Seeking Learning andKnowledge Process with an Online Environment in Queensland.Unpublished Ph.D. Thesis.

Tologbonse, D., Fashola, O., &Obadiah, M. (2008).Policy Issues in Meeting Rice Farmers Agricultural Information Needs in Niger State. *Journal ofAgricultural Extension*, **12**(2).

Twigg, J.(2007**)** Characteristics of A Disaster-Resilient Community: A Guidance Note. *Nat. Hazards Rev*., **1**, 1–40.

Twigg, J. (2009). Characteristics of A Disaster-Resilient Community. Guidance Note.NGO Inter-Agency Group. Http://Community.Eldis.Org/.59e907ee/Characteristics2EDITION.Pdf

Umar, S., Oteikwu, P. O., Shuaibu, H., Duniya, P. K., &Tanbari, I. W. (2015). Factors

Influencing Level of Satisfaction with Growth Enhancement Support Scheme Among Farm Families In Kaduna State, Nigeria. *Journal of Agricultural Extension*, **19**(1), 57-65. Https://Doi.Org/10.4314/Jae.V20i2.10

United Nations Office for Disaster Risk Reduction. (2012). How To Make Cities More Resilient: A Handbook For Local Government Leaders. Geneva: Author.

Van Den Ban, A. W. (1998). Supporting Farmers, Decision Making by Agricultural Extension. *Journal ofExtension Systems*, **14**, 55-67.

Vidanapathirana, N. P. (2019). Agricultural InformationSystems andTheir ApplicationFor Development of Agriculture And Rural Community, A Review Study. Available At: Https://Www.Researchgate.Net/Publication/336252494_Agricultural_Information_Systems_And_Their_Applications_For_Development_of_Agriculture_And_Rural_COmmunity_A_Review_Study

Villano, R. A., Magcale-Macandog, D. B., Acosta, L. A., Tran, C. D. T. T., Eugenio, E. A., &Macandog, P. B. M. (2020). Measuring Disaster Resilience in the Philippines: Evidence Using Network Data Envelopment Analysis. *Climate and Development*, **12**(1), 67-79.

Vinaya K. H. M., (2015). Management of Climate Induced Crisis by the Farmers of Coastal Region. Ph. D. Thesis (Unpub.), Dept. Agric. Extn, U. A. S., Bangalore.

Walker, B.H., Holling, C.S., Carpenter, S.R., Kinzig, A.P. (2004). Resilience, Adaptability and Transformability in Social–Ecological Systems.*Ecology and Society,***9**(2), 5 Http://Www.Ecologyandsociety.Org/Vol9/Iss2/Art5/

Wassie, S. B., Mengistu, D. A., &Birlie, A. B. (2023). Agricultural Livelihood Resilience in The Face of Recurring Droughts: Empirical Evidence from Northeast Ethiopia. *Heliyon*, **9**(6).

World Bank. (2010). Development and Climate Change. Washington, DC: Author

Wreford, A., Ignaciuk, A., &Gruère, G. (2017).Overcoming Barriers to the Adoptionof Climate-Friendly Practices in Agriculture.*OECD Food, Agric. Fisheries*, 101.

Yadav, B. S., Khan, I. M., & Kumar, M. (2011).Utilization Pattern of Different Sources and Channels of Agriculture Information Used by the Fenugreek Growers.*Indian Research Journal of Extension Education*, **11**(1), 44-49.

Yahaya, M. K. (1995). Determination of Agricultural Information Needs and Media Use Pattern of Women Farmers in North-Central Nigeria (Unpublished Doctoral Dissertation).University ofIbadan, Ibadan, Nigeria.

Yirga, C. T. (2007). The Dynamics of Soil Degradationand Incentives for Optimal Management in Central Highlands of Ethiopia.Ph.D, Thesis. Dept. Agric. Econ., Extn, Rural Development.Univ. Pretoria, South Africa.

Yoon, D. K., Kang, J. E., & Brody, S. D. (2016). A Measurement of Community Disaster Resilience in Korea. *Journal ofEnvironmental Planning andManagement*, **59**(3), 436-460.

Zhou, H., Wang, J. A., Wan, J., & Jia, H. (2010). Resilience to Natural Hazards: A Geographic Perspective. *Natural Hazards*, **53**, 21-41.

Zhou, H., Wang, X., & Wang, J. A. (2016). A Way to Sustainability: Perspective of Resilience And Adaptationto Disaster. *Sustainability*, **8**(8), 737.

Zurich Flood Resilience Alliance. (2019). The Flood Resilience Measurement for Communities (FRMC); Zurich Flood Resilience Alliance: Zurich, Switzerland.



APPENDIX

Appendix

RESEARCH SCHEDULE

Assessment of Agricultural Extension Needs of Farmers for Disaster Resilience in Dhemaji district of Assam

Department of Agricultural Extension, Faculty of Agriculture,
Uttar Banga Krishi Viswavidyalaya, Cooch Behar, West Bengal

Researcher: Indrajit Barman Chairman: Prof. K.Pradhan

A.SOCIO-PERSONAL ATTRIBUTES OF THE RESPONDENT

1. **Name of the Respondent:.....**
2. **Village: ..... Block:.....**
3. **Age (*in years*):.....**
4. **Farming experience (*in years*):.....**
5. **Education status**

Sl.No.	Qualification	Tick the appropriate response
1	Illiterate(0)	
2	Can read only(1)	
3	Can read and write/primary passed(2)	
4	Middle school passed(3)	
5	H.S.L.C passed(4)	
6	H.S/PU Passed(5)	
7	Graduate /diploma or above(6)	

6. **Family Educational status**

Sl.No.	Name of the family members	Relationship with respondent	Education(put the no. seeing the above table
1			
2			
3			
4			
5			
6			
7			

7. Family size:

Gender	Children below 14	Adult	Aged (Above 60)	Total
Male				
Female				

B.SOCIO-ECONOMIC ATTRIBUTES

1. Annual income

Sl.No.	Source	Income(*in Rs*)
1	Rice	
2	Pulse	
3	Mustard	
4	Livestock/Poultry	
5	Vegetables	
6	Fishery pond	
7	Others	

2. Annual expenditure

Sl.No.	Source	Expenditure(*in Rs*)
1	Crop production	
2	Food	
3	Clothing	
4	Education	
5	Housing	
6	Transportation	
7	Healthcare	
8	Festival	
9	Ceremony	
10	Mobile/TV	

3. Size of operational Land holding (ha)

Sl.No.	Type	Irrigated	Unirrigated	Total
1	Area of cultivable Land owned(a)			
2	Area of cultivable Land leased in for cultivation(b)			
3	Area of cultivable Land leased out for cultivation(c)			
4	Size of operational land holding = (a+b)-c			

4. Cropping Intensity

Sl.No.	Particular	
1	Gross cropped area in hectare(ha)	
2	Net cropped area in hectare(ha)	
3	Cropping Intensity in percentage (%)	

C.EXTENSION COMMUNICATION ATTRIBUTES

1. Social participation

Sl. No	Organization	Members/Office bearer	Extent of Participation		
			Frequently(2)	Sometimes(1)	Never(0)
1	Village Panchayat				
2	Village Cop. Society				
3	Self Help Group				
4	FPO/FPC				
5	Farmers Club				
6	Mahila Mandal				
7	Labour organization				

2. Extension contact

Sl. No	Categories of extension personnel	Response Categories		
		Frequently(2)	Sometimes(1)	Never(0)
1	VLEW/AEA			
2	ADO			
3	Agricultural Scientist/ KVK personnel			
4	NGO personnel			

3. Mass media exposure

Sl. No	Categories of extension personnel	Response Categories		
		Frequently(2)	Sometimes(1)	Never(0)
1	Newspaper			
2	Radio			
3	Television			
4	Computer(Internet)			
5	Mobile phones			
6	Farm publication			
7	Documentary film			
8	Exhibition			
9	Demonstration			
10	Others			

4. Training Exposure to Agriculture and allied activities

Sl. No	Sources of Training	Number of Days		
		1	1-3	Above 3
1	State Department			
2	KVK			
3	FPO/Farmers Club			
4	NGO			
5	University			
6	Others……..			

D.SOCIO-PSYCHOLOGICAL ATTRIBUTES

1. Innovativeness

Sl. No.	Statements	Farmers response		
1	A progressive farmer has to know about the recent development scientific practices against climate change. a)Do you know about such practices ?	**Yes(2)**	**Undecided(1)**	**No(0)**
2	A progressive farmer has to accept the improved practices to avert climate change risk which gives more income a) Do you try to follow such improved practices? b) Do you accept new varieties when they are recommended?			
3	When new varieties are recommended a progressive farmer has to help other farmers to adopt them a)Do you tell other farmer about the benefits of new varieties ? b)Do you help other farmers to follow improved practices			
4	A progressive farmer is one who adopt the improved practices to avert climate change risk immediately (or) follow ahead of others a) In your village are you the first person to adopt the improved practices? If specify them b) If no have you adopted any new practices recommended in last two years ahead of the other farmers ?			
5	A progressive farmer should have contact with extension agency a)Have you approached extension workers to get advice to avert climate change risk?			
6	A progressive farmer should cultivate superior varieties or high yielding varieties. a) Did you cultivate such varieties in the last years?			
7	A progressive farmer should follow the Integrated Pest and Disease Management on climate change a) Do you follow the neem based application?			

2. Economic motivation

Sl.No	Statements	Farmers response				
		SA (7)	A (5)	UD (4)	DA (3)	SDA (1)
1.	A farmer should work towards higher yield and economic profits.					
2.	The most successful farmer is the one who makes the most profit.					
3.	A farmer should try to adopt new farming ideas which may fetch him more return.					
4.	A farmer should grow cash crop to increase monetary profit in comparison to growing of food crops for home consumption.					
5.	It is difficult for the farmer's children to make good start unless he is provided with economic assistance.					
6.	A farmer must earn his living but the most important things in life cannot be defined in economic terms.					

3. Scientific orientation

Sl.No	Statements	Farmers response				
		SA (7)	A (5)	UD (4)	DA (3)	SDA (1)
1.	New methods of farming give better results to farmers than old methods					
2.	The way your forefathers did the farming is still the best way					
3.	Even a farmer with lots of experience should use new methods of farming					
4.	Though it takes time for a farmer to learn new methods of farming, it is worth the efforts					
5.	A good farmer experiments with new ideas of farming					
6.	Traditional methods have to be changed in order to raise the level of living					

4. Management Orientation

Sl.No	Statements	Farmers response			
		SA (4)	A (3)	DA (2)	SDA (1)
A.	**Planning Orientation**				
	(i)Each year one should think afresh about the crops to be cultivated in each type of land				
	(ii) It is not necessary to make prior decision about the variety of crop to be cultivated				
	(iii)The amount of seeds, fertilizers and plant protection chemicals needed for raising a crop should be assessed before cultivation				
	(iv)It is necessary to think ahead of the cost involved in raising a crop				
	(v)One need not consult an agricultural expert for crop planning				
	(vi)It is possible to increase the yield through farm production plan				
B.	**Production Orientation**				
	(i)Timely planning of crop ensures good yield				
	(ii) One should use as much as fertilizer as he /she likes				
	(iii) Determining fertilizer dose by soil testing				
	(iv) Seed rate should be given as recommended by the specialists				
	(v)For timely weed control one should even used suitable herbicides				
	(vi)With low water rate one should use as much as irrigation as water available				
C.	**Market Orientation**				
	(i)Market news is not useful to a farmer				
	(ii)One can get better price by grading his produce				
	(iii)Warehouses can help the farmer to get better price of his produce				
	(iv)One should purchase his inputs from where his other relatives purchase.				
	(v)One should sell his produce to the nearest market irrespective of price.				
	(vi)One should grow those crops which have more market demand.				

5. Risk bearing ability

Sl. No.	Statements	Farmers response				
		SA (7)	A (5)	UD (4)	DA (3)	SDA (1)
1.	A farmer should grow large number of crops to avoid greater risks involved in growing one or two crops					
2.	A farmer should rather take more of a chance in making big profit than to be content with a smaller, but less risk profit					
3.	A farmer who is willing to take greater risks than average farmer usually does better financially					
4.	It is better for a farmer not to try new farming methods unless most other farmer have used them with success					
5.	Trying an entirely new method in farming by a farmer involves risk but it is worth					

6. Emotional intelligence

Sl No	Statements	Farmers response				
		SA (7)	A (5)	UD (4)	DA (3)	SDA (1)
	A. Self Awareness					
1.	I am aware of my goals and values					
2.	I am aware of my strengths and weaknesses.					
3.	I try to learn from experiences.					
4.	I am open to continuous learning, self development, new perspectives &honest feedback.					
5.	I am able to show sense of humour and perspective about myself.					
6.	I am organised and careful in my work					
	B.Emotion Regulation					
1.	I feel happy and satisfied about my life.					
2.	I can predict clearly whether my emotion is happy or sad.					
3.	I am someone who is original and don't copy others.					
4.	I am quite a cheerful and lively person					
5.	I can win over stress without getting too nervous					

6.	I feel cool, relaxed & stress free most of the times					
	C.Self Motivation					
1.	I am result-oriented with a high drive to meet objectives and goals					
2.	I continuously learn in order to improve my performance.					
3.	Before beginning something new, I usually feel that I will succeed.					
4.	I am generally motivated to continue, even when situations become worse to handle.					
	D.Social Awareness					
1.	People think that I am optimistic and self-confident person.					
2.	Others think that I lack confidence in interacting with others.					
3.	I see variety in people as opportunity, creating an environment where diverse people can prosper					
4.	It's quite easy for me to understand the non verbal messages(facial expressions) of others					
5.	I can tell how others are feeling by listening to their voice of tone					
	E.Social Skills					
1.	I am skilled at the art of convincing others					
2.	I am easy to get friendly and possess good social skills.					
3.	I am extremely polite & respectful to others irrespective of the unfavourable circumstances.					
4.	I look forward to relationships that are mutually useful.					
5.	I promote a friendly and cooperative climate					
	F.Emotional Receptivity					
1.	I help others in coming out of difficult situations.					
2.	I extend support and advice to others when needed.					
3.	I offer useful feedback and identify people's needs for development					
4.	I listen well, seek mutual understanding and fully welcome sharing of information.					
5.	I am more of a leader than a follower					
6.	I act as a mediator in resolving conflict between two parties					

PART-II

Computation of the farmers' disaster resilience

A. Economic Dimension

Sl.No	Economic Indicators	Response				
		Very High	High	Medium	Low	Very Low
A1	Diversity of Income source					
A2	Off-season Income					
A3	Recovery of income owing to a recent flood/drought/storm disaster					
A4	Receiving financial help from family members and relatives					
A5	Access to credit facility for farming activities					
A6	Access to credit facility to prevent disaster					
A7	Household saving practice					
A8	Crop insurance Accessibility					
A9	Availability of subsidies for field drainage infrastructure					
A10	Availability of subsidies for flood/drought-resistant agri inputs (seeds ,fertilizers etc)					
A11	Availability of subsidies/ incentives for farmers to reclaim flood/drought-affected lands					
A12	Cultivating Rabi crops after Kharif crops					
A13	Access to seed bank					
A14	Access to cold storage facilities					
A15	Availability of proper storage facilities					
A16	Availability of Radio					
A17	Availability of TV					
A18	Availability of Computer with internet					
A19	Availability of Mobile phones with Internet					
A20	Availability of Mobile phones without Internet					
A21	Availability of Motorized vehicle					
A22	Availability of water pump					
A23	Availability of farm tractor/power tiller					
A24	Availability of improved farm tools and implements					
A25	Application of agricultural technology in your farm					
A26	Availability of Business partnership with others					
A27	Ability to sale your farm produce (Bargaining power)					

B. Social Dimension

Sl. No	Social Indicators	Response				
		Very High	High	Medium	Low	Very Low
B1	Household contribution to farm labour during and post disaster period					
B2	Contribution of extended family members/relatives towards farm labour during and post disaster period					
B3	Activeness in any Farmer based organization(FPO,FIG,CIG,SHG etc					
B4	Awareness level about climate change					
B5	Availability of public awareness programmes on flood/drought/storm etc disaster					
B6	Access to internet/social media					
B7	Access to Extension and Advisory Service (climate, farm disaster management training etc.)					
B8	Access to Basic Service (Health care)					
B9	Access to Basic Service (Drinking water)					
B10	Access to Basic Service (Shelter/safe house,)					
B11	Access to Basic Services (Electricity)					
B12	Access to Basic Services (Transport)					
B13	Availability of Social safety Net(Assistance in cash/ kind,)					
B14	Availability of Social safety Net(Job assistance/MGNREGA)					
B15	Availability of Social safety Net(PDS)					
B16	Availability of Social safety Net(Old Age pension Scheme)					
B17	Availability of Relief material					
B18	Availability of Social safety Net(IAY/PMAY)					

C. Technical Dimension

Sl. No.	Technical Indicators	Response				
		Very High	High	Medium	Low	Very Low
C1	Knowledge of flood resistant Varieties					
C2	Knowledge of drought resistant Varieties					
C3	Knowledge of early maturing varieties					
C4	Knowledge of intercropping					
C5	Knowledge of relay Cropping					
C6	Knowledge of integrated nutrient management					

C7	Knowledge of crop rotation					
C8	Knowledge of multiple cropping					
C9	Knowledge of integrated farming System					
C10	Knowledge of unconventional production practices(poly house/green house cultivation etc)					
C11	Knowledge of unconventional production practices (Knowledge of changed planting/sowing dates)					
C12	Knowledge of modern plant protection technologies					
C13	Access to daily weather Data					
C14	Access to flood/drought/storm disaster Warnings					
C15	Access to weather predictions from reliable sources (GKMS/IMD etc.)					
C16	Knowledge of applications/websites developed for sharing climate/weather information					

D. Physical Dimension

Sl. No.	Physical Indicators	Response				
		Very High	High	Medium	Low	Very Low
D1	Fully owned operational land holding					
D2	Long term tenure operational land holding					
D3	Availability of upland operational land holding(flood free)					
D4	Availability of irrigation facilities					
D5	Availability of proper drainage system in your farm land					
D6	Availability of Farm pond					
D7	Access of farm to the nearby main road					
D8	Access to farm roads from house during flood events					
D9	Availability of uninterrupted road after disaster events					
D10	Access to electricity for agriculture purpose					
D11	Availability of uninterrupted electricity					

PART-C

Assessment of the Agricultural Extension Needs of farmers

Following are a few farmers' extension needs. Please rank the each extension need within each thematic area under particular dimension

Dimension and Theme wise items on farmers' extension needs	**Rank**
A) Up to date information	
I. Thematic Area - *Agricultural Inputs*	
1.Information on flood and drought resistant varieties and disease and pest resistant varieties	
2. Information on HYVs, hybrids seeds	
3. Information on good quality and certified seeds of improved varieties	
4.Information on techniques and method of seed production at your farm	
5.Information related to crop- wise recommended dose of fertilizers	
6. Information on sources and availability of fertilizers	
7. Information on different methods of fertilizer application (basal application, topdressing, etc.)	
8.Information on water efficient crops (less water requirement)	
9.Iinformation on water harvesting techniques	
10.Information on related to service/subsidies/Schemes in Irrigation sector	
11. Information on sources and services related to plant protection	
12. Information on related to different pesticides and their usages	
13. Information on equipment and implements required for different agricultural operations	
14. Information on prices and subsidy schemes of Govt. for machineries, equipment and implements	
15.Information on crop contingency plan	
16.Information on labour saving technologies	
II. Thematic Area - *Agricultural Finance*	
1.Information related to agricultural loans	
2. Information on financial assistance for production of specific crops (like medicinal plants, commercial crops, horticultural, floricultural crops etc.)	
3.Information services on subsidies given by the Govt. for agricultural sector	
4.Information on amount of subsidies given by Govt. for produce and different farm inputs like seeds,fertilizers,irrigation and farm tools and machineries etc	
5.Information on agencies providing insurance services in agricultural sector	
6.Information on Pradhan Mantri Fasal Bima Yojana (PMFBY)	
III. Thematic Area - *Agricultural Production*	
1. Information on soil testing service	
2.Information on the universal soil health card scheme	
3.Information on current updates of weather	
4.Information on weather forecasting	
5.Information on preparedness against natural calamities	
6.Information on integrated nutrient management	
7.Information or advisory services for choosing the pesticide according to the pest incidence	
8. Information and knowledge on IPM	

9. Information on latest technologies/ equipment for harvesting	
IV. Thematic Area - *Post Harvest Management*	
1. Information on latest processing technologies for farm production	
2. Information on value addition of your farm produce	
3. Information on contact details of nearby storage facilities	
4. Information on subsidy or credit schemes for storing	
5.Information on latest machines and technologies for grading	
V. Thematic Area - *Marketing*	
1.Online market information	
2. Information on which products have a high demand in the market	
3.Information on improved marketing practices	
4. Information on current prices	
VI. Thematic Area - Livelihood Diversification	
1. Information for ancillary occupation to increase household income	
2. Information on Integrated Farming System	
3. Information on crop diversification through low volume high value product	
4. Information on how and when should you change the farm enterprise combination (e.g. agril. diversification)	
5.Information on innovations that are capable of boosting your farm productivity and economic development	
B.Advisory Service **(Training and Demonstration)**	
I. Thematic Area - *Agricultural Inputs*	
Training and/or Demonstration on efficient use of Agricultural Inputs	
i.Seeds	
ii.Fertilizers	
iii.Irrigation	
iv. Plant protection	
v. Farm implements and machineries	
II. Thematic Area - *Agricultural Finance*	
Training and/or Demonstration on the agricultural finance related issues	
i.KCC/Credit	
ii.Crop Insurance(PMFBY)	
iii.Subsidies	
III. Thematic Area - *Agricultural Production*	
Training and/or Demonstration on the agricultural production &management aspects	
i.Soil health and nutrient management	
ii.Pest and Disease management	
iii)Preparedness/crop Contingency planning against natural calamities or disaster/hazards	
IV. Thematic Area - *Post Harvest Management*	
Training and/or Demonstration on the agricultural post harvest activities	
i.Processing	
ii.Value addition	
iii.Storing	
iv.Grading	
v. Packaging	
V. Thematic Area - *Marketing*	

i. Training and/or Demonstration on the marketing or trading related aspects of your farm produce	
VI. Thematic Area - Livelihood Diversification	
Training and/or Demonstration on the following livelihoods diversification activities	
i.)Agricultural Diversifications	
ii.)Crop Diversifications(High value Crops)	
iii)Integrated Farming System	
iv)Entrepreneurship Development	
v)Secondary Agriculture	
vi.)Custom Hiring Centre	
C.Mitigation Strategy	
I. Thematic Area - *Agricultural Production*	
1.Cultivating flood tolerant rice varieties	
2.Cultivating drought tolerant rice varieties	
3.Cultivating short duration *Sali* rice cultivar for dry spell management	
4.Cultivating medium duration *Sali* rice Cultivar for dry spell management	
5. Crop diversification for flood water management	
6.Crop diversification for dry spell management	
7.Cultivating Short duration *Sali* rice Cultivar for post flood situation	
8.Cultivating Short duration *Sali* rice Cultivar for pre flood situation	
9.Cultivating short duration Boro rice (Summer season) varieties for escaping flood	
10.Cultivating short duration pulses such as green gram, black gram, cowpea and millet for escaping drought like situation	
11.Cultivating Maize in the driest period of the year	
12.Practising Rain water harvesting in farm ponds for growing rabi crops	
13. Practising Rain water harvesting in farm ponds in raising seedling of *Sali* rice	
14. Use of organic manure (vermi compost/compost) for drought/ dry spell management in *Sali* rice	
15.Application of NPK for drought management in *Sali* rice	
16.Practising protected cultivation of high value crops against hail storm	
17.Practising In-situ rain water harvesting for moisture conservation(mulching)	
18. Practising Mixed cropping and inter cropping	
19. Diversification of Farming system	
II. Thematic Area - *Institutional Building*	
1. Establishing Seed Bank	
2. Establishing fodder bank/ growing fodder crops for managing animal feeds	
3. Establishing Custom Hiring Centre	
4. Establishing FPO/FPC	
5.Regulated Market	

PART-D

Challenges associated with farmers' agricultural extension needs and disaster resilience

Following are a few challenges associated with farmers' extension needs and disaster resilience. Please rank the each challenges within each category..

A.Socio- Economic Challenges	**Rank**
1.Poor level of awareness and education	
2.Reluctant to change existing practices	
3.Poor adoption of improved agricultural technologies	
4.Lack of exposure to agricultural development	
5.Poor perception and understanding on the Technologies	
6.Complexity of the demonstrated Technologies	
7.Inadequate access to training and demonstration	
8.Multidimensional extension needs	
9.Lack of formal credit facilities	
10.Lack of crop insurance facilities	
11.Inadequate subsidy facilities	
B. Technical challenges	
1.Changing weather pattern	
2.Various type/natures of disaster and their changing magnitude level	
3.Unpredictability nature of disaster events	
4.Poor knowledge of improved farm disaster management practices	
5.Lack of available location specific disaster resilience agricultural technology	
6. Poor access to disaster resilience agricultural technology.	
7.Inadequate crop Contingency planning	
8.Poor access to early warning system	
9. Non availability of weather report in local language	
10. Non availability of timely farm advisories.	
C. Physical and Infrastructural Challenges	
1.Poor ICT Infrastructure	
2.Non availability of Training Institute nearby	
3.Lack of Training Hall with standard facilities	
4.Lack of Irrigation facilities	
5.Non availability Cold storage facilities	
6.Lack of farm drainage facilities	
7.Poor Transportation facilities	
8.Poor road condition and connectivity	
9.Inadequate communication Network	
10.Non availability of Extension functionaries office nearby	
D. Organizational/Institutional Challenges	
1. Lack of Seed Bank	
2. Non availability of fodder bank	
3.Lack of Custom Hiring Centre	
4. Lack of FPO/FPC	
5. Non availability of Regulated Market	
6.Lack of agricultural shop nearby	

Signature of Respondent

Date:

Signature of Researcher

Date:

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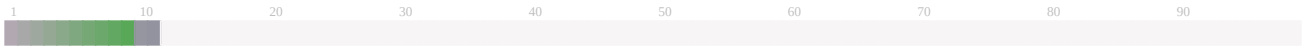
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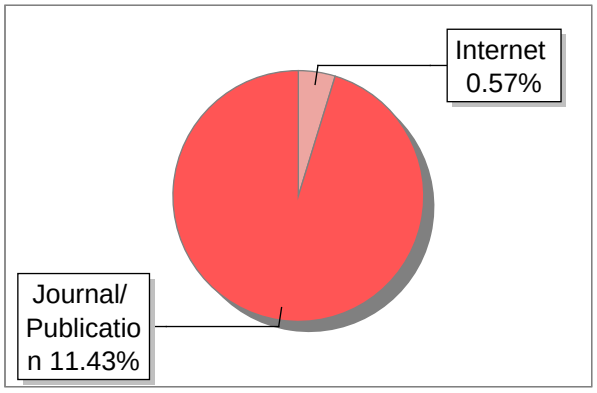
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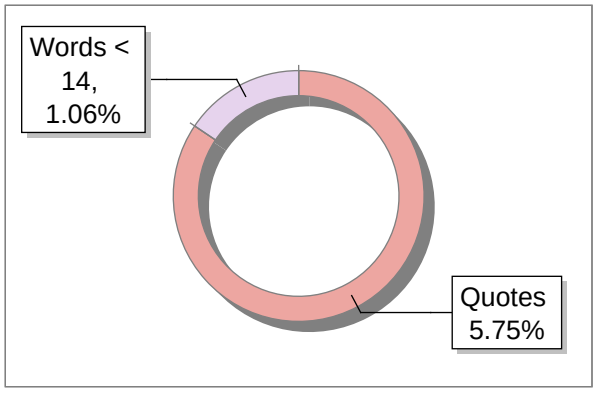
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IRJEE SOCIETY OF EXTENSION EDUCATION

RESEARCH ARTICLE

Assessing Farmers' Perception on Disaster Risk Mitigation Practices of Flood Prone areas of Dhemaji district, Assam

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ABSTRACT

Floods, droughts, storms, earthquakes, fires and severe weather conditions have significant, widespread and long-lasting impacts on the agricultural sector. The study was conducted in flood prone areas of Dhemaji district of Assam to assess the farmers' perception on disaster risk mitigation practices and study selected personal, socio-economic, psychological and communication attributes of farmer respondents as well as to find out the relationship between perception of farmers on disaster risk mitigation practices with the selected personal, socio-economic, psychological and communication attributes of the respondents. A multi-stage, purposive cum random sampling design was used in the study for selecting 100 sample respondents. The study revealed that most of the respondents were young to middle aged, marginal farmers and had medium level of formal education. Majority of them belonged to the low and medium level of annual income categories and had medium level of economic motivation, scientific orientation, extension contact and mass media exposure. The perception Index indicates that high majority of the farmers showed favourable perception on disaster risk mitigation practices. Correlation analysis of the independent variables of the study with perception of farmers on disaster risk mitigation practices revealed that six independent variables, viz., size of land holding, extension contact, mass media exposure, age, education and risk bearing ability were positively and significantly correlated with mitigation practices. Appropriate agricultural technology interventions suited for hazards affected areas may be planned keeping in mind farmers' favourable perception on technologies and their socio-economic attributes.

Key words *: Farmers' Perception; Disaster Risk Mitigation; Perception Index; Flood Prone.*

Multiple disasters have imposed devastating consequences on agriculture, food security and the livelihoods of millions of farmers. Natural disaster mainly floods, draughts, cyclone and hailstorms are posing threat to food and livelihoods security for millions of people. A recent FAO study found that between 2006 and 2016, the agriculture sector absorbed approximately 23 percent of all damages and losses caused by natural hazard-induced disasters in developing countries (FAO, 2018). If not prevented, these impacts will continue to have major negative implications on food security and poverty around the globe. There are multiple pathways to reduce the impacts of natural hazard induced disasters on the agriculture sector, at different levels – including farm level. Prevention and Mitigation are considered as key elements of the disaster risk management (DRM) framework for Agriculture (*OECD/FAO, 2021*).

A number of agricultural disaster mitigation practices are developed, available and being disseminated through various extension and advisory service agencies for the farming community. Numerous studies have been conducted on the adoption of agricultural technologies in developing countries, particularly focussing on socio-economic situations and farm attributes (*Feder et al. 1985*; *Doss and Morris 2000*; *Lapar and Ehuri 2004*). There are many factors that influence adoption decision like individual farmer's behaviour based on the self perception towards new technologies (*Burton 2004*; *Cramerer and Loewerstein 2004*; *Garforth et al. 2004*; *Rehman et al., 2007*; *Azman et al. 2013*; *Datta and Mullainathan 2013*). An analysis

of adoption studies stated that there are three paradigms of reasons why some farmers adopt new technologies and others do not. These are the innovation-diffusion paradigm ; the economic constraints paradigm and the adopter-perception paradigm (*Adesina & Zinnah,1993* ; *Prager & Posthumus, 2010).* The adopter-perception paradigm allows for a level of subjectivity by contending that it is the perceived need to innovate and the perceived attributes of innovations that determine adoption behaviour (*Kivlin and Fliegel,1967*, *Adesina and Zinnah,1993*. It is stated that favourable perception on developed technologies is another pre requisite for technology adoption. Farmers' perception assessment on disaster mitigation practices is needed to facilitate the adoption for improving their adaptive capacities**.** With this context, a study is designed to assess the farmers' perception on disaster risk mitigation practices, study selected personal, socio-economic, psychological and communication attributes of farmer respondents as well as to find out the relationship between perception of farmers on disaster risk mitigation practices with the selected personal, socio-economic, psychological and communication attributes of the respondents.

METHODOLOGY

The present study was carried out in Dhemaji district under North Bank Plain Agro-Climatic Zone of Assam. A multi-stage, purposive cum random sampling design was adopted for the study in order to select 100 respondents. Data were collected with the help of a pretested, structured research schedule, using the personal interview method. A total of fourteen farm disaster risk mitigation practices were considered for the study based on experts' opinion. A Likert type scale was prepared to measure the perception of farmers towards disaster risk mitigation practices. Responses were scored on a 5 point continuum ranging from 5= 'Strongly Agree' to 1= 'Strongly Disagree'. The respondents were asked to rank the statements as per their view point. The perception Index was calculated out using the formula

$$\text{Index on perception} = \frac{\text{Scored obtained by Individual}}{\text{Maximum score}} \times 100$$

The statistical techniques and tests such as frequency, percentage, mean, standard deviation, co-efficient of variation, Pearson's product moment correlation coefficient and t-test were used in the study for analysis and interpretation of data.

RESULTS AND DISCUSSION

Attributes of the respondents : A total of nine independent variables *viz*., age, education, family size, size of land holding, annual income, economic motivation and risk bearing ability, extension contact and mass media exposure were considered for the study. The respondents were categorized on the basis of descriptive statistics in relation to each attribute.

Age, education and family size : A perusal of Table 1 reveals that majority of the respondents (56.00%) belonged to the middle age category followed by young age category (33.00%). Only 11.00 per cent of the respondents belonged to the old age category. The mean value (43.76) indicates that on an average the respondents belonged to middle aged category. The coefficient of variation (29.54%) indicates that the respondents were moderately heterogeneous with respect to their age.

The Table 1 also reveals that majority of the respondents (29.00%) had formal education up to high school level, followed by those having education up to middle school level (27.00%). Significantly, 17 per cent of the respondents were illiterate. A few respondents (11.00%) were primary school passed and 10 per cent of them had higher secondary level of education. Only 2.00% of the respondents were found to be graduates or above. The coefficient of variation (58.98%) indicates that the respondents were highly heterogeneous with respect to their education. The finding shows that the majority of the respondents had relatively low level of formal education, as indicated by the mean value (2.95).

As revealed by table, majority of the respondents (47.00%) in the study area had medium size of family followed by respondents having small family size (44.00%). Only 9 per cent of the respondents had large size of family. The coefficient of variation (36.66%) indicated that the respondents were moderately heterogeneous with respect to their family size.

Size of land holding and annual income : Data presented in the Table 1 reveals that majority of the respondents (57.00%) were marginal farmers followed by small farmers (33.00%). Small proportions were semi-medium (7%) and medium farmers (3%). There were no large farmers among the respondents. The value of coefficient of variation (76.81%) indicated that the respondents were highly heterogeneous with respect to their operational land holding size.

The Table also highlights that 43.00% of the respondents had annual income in the range of Rs. 50001-

Table 1. Distribution of respondents according to their age, education and family size

Category	Score range	No.	%	Mean	S.D.	C.V.
Age						
Young	18 to 35 years	33	33.00			
Middle aged	36 to 59 years	56	56.00	43.76	12.93	29.54
Old	>60 yrs and above	11	11.00			
Education						
Illiterate	0	17	17.00			
Can read only	1	4	4.00			
Primary level	2	11	11.00	2.95	1.74	58.98
Middle level	3	27	27.00			
High school level	4	29	29.00			
H.S. /P.U. level	5	10	10.00			
Graduate or above	6	2	2.00			
Family Size						
Small family	size Up to 4	44	44.00	5.21	1.91	36.66
Medium family	size 5-7	47	47.00			
Large family	size 8 and above	9	9.00			
Size of land holding						
Category	Score range	No.	%	0.979	0.752	76.81
Marginal	Below 1.0 ha	57	57.00			
Small	1.0-2.0 ha	33	33.00			
Semi-Medium	2.0-4.0 ha	07	7.00			
Medium	4.0-10.0 ha	03	3.00			
Large	10.0 ha and above	0	0.00			
Annual income						
Below Rs.22000/- per year (Poverty line)	1	05	5.00	2.93	1.07	36.51
22000 – 50000/- per year	2	32	32.00			
50001 – 75000/- per year	3	43	43.00			
75001 - 1,00,000/- per year	4	08	8.00			
>1,00,000/- per year	5	12	12.00			
Economic motivation						
Category	Score range	No.	%	29.98	5.38	17.94
Low	< 25.89	13	13.00			
Medium	25.89 to 37.32	70	70.00			
High	>37.32	17	17.00			
Risk bearing ability						
Low	Up to 24.96	17	17.00	31.56	5.39	17.07
Medium	24.96 to 35.11	69	69.00			
High	Above 35.11	14	14.00			
Extension contacts						
Low	1 to 2	41	41.00	3.19	0.84	26.33
Medium	3 to 4	54	54.00			
High	5 and above	5	5.00			
Frequency of extension contact	Regularly (2)	Sometimes(1)	Never (0)	100		
VLEW	11	66	23	100		
ADO	2	7	91	100		

Scientist/KVK personnel	1	6	93	100		
NGO personnel	1	3	95	100		
Mass media exposure	Score range	No. (n=80)	%	Mean	S.D.	C.V.
Low	8 to 10	35	35.00	12.05	2.03	16.85
Medium	11 to 14	54	54.00			
High	15 to 18	11	11.00			
Frequency of mass media exposure	Regularly(2)	Sometimes(1)	Never(0)	Total		
Newspaper	12	27	61	100		
Television	43	51	6	100		
Mobile phone	23	43	34	100		
Farm Publication	1	14	85	100		
Exhibition	6	21	73	100		

Table 2. Perception of Farmers about Disaster risk mitigation practices

Statements	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Flood tolerant rice varieties can withstand the flood water	5(5.00)	66(66)	14(14.00)	9(9.00)	6(6.00)
Short duration *sali* rice Cultivar can be grown for dry spell management	0(0.0)	13(13.00)	69(69.00)	18(18.00)	0(0.00)
Medium duration *sali* rice Cultivar can be grown for dry spell management	0(0.0)	8(8.00)	77(77.00)	15(15.00)	0(0.00)
Short duration *sali* rice Cultivar can be grown in post flood situation	2(2.00)	23(23.00)	62(62.00)	9(9.00)	4(4.00)
Maize can be grown in the driest period of the year	4(4.00)	35(35.00)	44(44.00)	11(11.00)	6(6.00)
Rain water harvesting in farm ponds can help in growing rabi crops	15(15.00)	36(36.00)	39(39.00)	10(10.00)	0(0.00)
Rain water harvesting in farm ponds can help in raising seedling of *Sali* rice	12(12.00)	35(35.00)	41(41.00)	22(22.00)	0(0.00)
Use of organic manure (vermi compost/compost) helps in growing crop in post flood situation	11(11.00)	74(74.00)	13(13.00)	2(2.00)	0(0.00)
Diversification of Farming system may mitigate the farm disaster impact	4(4.00)	43(43.00)	51(51.00)	2(2.00)	0(0.00)
Animal feed can be managed through fodder bank/ growing fodder crops	16(16%)	67(67.00)	13(13.00)	4(4.00)	0(0.00)
Protected cultivation of high value crops helps farmers to recover from disaster loss	3(3.00)	12(12.00)	76(76.00)	6(6.00)	3(3.00)
In-situ rain water harvesting for moisture conservation(mulching) will help dry spell management	2(2.00)	23(23.00)	69(69.00)	6(6.00)	0(0.00)
Double cropping will help farmers to recover from disaster loss	9(9.00)	53(35.00)	32(32.00)	5(5.00)	3(3.00)
Seed Bank will help farmers in post disaster situation	12(12.00)	79(79.00)	16(16.00)	3(3.00)	0(5.00)

75000/- per year and 32 per cent of the respondents falling in the range of Rs. 22000 – 50000/- per year. A small size of the respondents (12%) had annual income above Rs. 1,00,000/-, while 8% of the respondents had annual income in the range of Rs. 75001 – 1,00,000/-. The Below Poverty Line (BPL) category accounted for 5% of the respondents. The mean value (2.93) indicates the low annual income level of the respondents, while the coefficient of variation (36.51%) indicated that the respondents were moderately heterogeneous with

respect to their annual income.

Economic motivation and risk bearing ability : The findings related to economic motivation and risk bearing ability are presented in Table 1. It is evident from the table that majority of the respondents (70.00%) had medium level of economic motivation, followed by 17.00% with high level of economic motivation. Only 13 per cent of the respondents were found to have low level of economic motivation. The coefficient of variation (17.94%) indicated that the respondents were relatively homogenous with respect to their economic motivation. The standard deviation figure (5.38) also shows that respondents by and large spread around the mean value (29.98), which explained medium strength of economic motivation.

The Table highlights that majority of the respondents (60.00%) had medium level of risk bearing ability, followed by 17.00 per cent with low level of risk bearing ability. Only 14.00 per cent of the respondents were found with high level of risk bearing ability. The standard deviation value (5.39) and the coefficient of variation (17.07%) indicated that the respondents were homogenous with respect to their risk bearing ability. It is stated that high annual income and more operational landholdings increase the risk bearing ability of the farmers. On both these aspects the respondents were poor and hence they did not have high risk bearing ability.

Extension contact : The findings presented in Table 1 reveals that the majority of the respondents (54.00%) had medium level of extension contact followed by 41.00 per cent with low level of extension contact and only 5.00 per cent of the respondents were found with high level of extension contact. The value of co-efficient of variation (26.33) indicated that the respondents were relatively homogeneous with respect to their extension contact.

The distribution of respondents according to frequency of contact with different sources is presented in Table 1. It is evident from the Table that 11.00 per cent of the respondents had regular contact with VLEW. Only one to two respondents were found to have regular contact with ADO, Scientist /KVK personnel and NGO personnel. Majority of the respondents (66.00%) had contact with VLEW sometimes, followed by 7.00 per cent of the respondents who contacted with ADO sometimes and then 6.00 per cent had contact with Scientist /KVK personnel. Only3.00 per cent of them were found having contact with NGO personnel sometimes. Majority of the respondents (above 90.00%) never contacted ADO, Scientist /KVK personnel and NGO personnel and 23.00 per cent had never contacted with VLEW.

Mass media exposure : It is evident from Table 1 that majority of the respondents (54.00%) had medium mass media exposure, followed by 35.00 per cent with low mass media exposure. Only 11.00 per cent of the respondents had low mass media exposure. The value of co-efficient of variation (16.85) indicated that the respondents were relatively homogeneous with respect to their level of mass media exposure. The distribution of respondents according to frequency of use of different mass media is presented in Table 1. It is evident from the Table that majority of the respondents (43.00%) used television regularly followed by 23.00 per cent used mobile phone regularly and 12.00 per cent of the respondents used newspaper regularly as their source of information. While 6.00 per cent visited exhibition regularly and only one to three respondents used farm publication and attended demonstration regularly as their source of information. Majority of them (51.00%) used television sometimes followed by 43.00 per cent of the respondents who sometimes used mobile phones as their source of information. Only 21.00 per cent and 19.00 percent of respondents sometimes visited exhibition and demonstration while 27.00 per cent and 14 per cent of them sometimes used newspaper and farm publication as their information source. Majority of them (85.00%) never used farm publication followed by 78.00 per cent of the respondents who never attended demonstration as source of information while 73.00 per cent and 61.75 per cent of them never visited exhibition and used newspaper as their source of information. A sizeable number of respondents (34.00%) never used mobile phone and only 6.00 per cent of them never viewed the television as source of information.

Perception of farmers about disaster risk mitigation practices : The perception of farmer respondents about disaster risk mitigation practices was assessed using a set of 14 statements. The findings are presented in the **Table** 2 and it reveals that majority of the respondent were agree with a few statements related to seed bank, use of organic manure/vermicompost, fodder bank, flood tolerant rice varieties and double cropping. About 79.00 per cent and 74.00 per cent of farmer perceive that seed bank and use of organic manure will help them in growing crop in post flood situation. Bulk of the farmers (67.00% and 66.00%) believe that animal

Table 3. Perception Index of farmers Respondents

Value	Category	No.	%
1-19	Highly Unfavourable	0	0
20-39	Unfavourable	0	0
40-59	Somewhat favourable	18	18
60-79	favourable	79	79
80-99	Highly favourable	3	3
Total		100	100

feed can be managed through fodder bank and flood tolerant rice varieties can be grown in flood situation.

The Table also indicates that majority of the farmer respondent are confused with other disaster risk mitigation practices such as medium and short duration *sali* rice cultivar for dry spell management and post flood situation, protected cultivation, *in-situ* rain water harvesting and diversification of farming system. Most of the farmers (77.00% and 69.00%) are confused with the statements on medium duration *sali* rice cultivar and short duration *sali* rice cultivar for dry spell management. About 69.00 per cent and 62.00 per cent of the farmers are neither agree nor disagree with statements on *in-situ* rain water harvesting for moisture conservation (mulching) for dry spell management and growing short duration *sali* rice cultivar in post flood situation. However, a sizeable 22.00%, 18.00% and 15.00 % of farmer respondents are disagree with the statements on rain water harvesting in farm ponds for raising seedling of *sali* rice, short duration and medium duration *sali* rice cultivar for dry spell management respectively.

A perception Index was also calculated for each respondent and based on the scores obtained, respondents were grouped into five categories. The categories of farmers respondents based on their frequency; percentages are presented in the **Table 3**. The perception Index indicates that high majority (79.00%) of the farmers showed favorable perception on disaster risk mitigation practices whereas 18 per cent showed somewhat favorable perception and the rest (3.00%) belonged to highly favourable group.

Correlation coefficient between perception of farmers on disaster risk mitigation practices and the selected attributes of the respondents : The findings of **the Table 4** indicates that size of land holding, extension contact, mass media exposure are significantly correlated at the 0.01 level and the other variables, i.e., age, education and risk bearing ability are correlated at the 0.05 level with perception of farmers on disaster risk mitigation practices.The strength of the relationship, as indicated by the 'r' values, suggest that the relationship are fairly strong with size of land holding , extension contact and mass media exposure while it is of moderate strength for the remaining three correlated variables. The relationships are found to be non-significant for the other three independent variables, *i.e.,* family size, annual income and economic motivation with perception of farmers on disaster risk mitigation practices. The findings of the present study are substantiated by the findings of *Kumari, et al. (2020)* and *Manjusree, R.V. et al. (2022).*

Table 4. Correlation coefficient between perception of farmers on disaster risk mitigation practices and the personal attributes of the respondents

variable	(r)	't' value
Age	0.210	2.126308*
Education	0.271	2.775962*
Family size	(-)0.026	0.25747^{NS}
Size of land holding	0.462	5.156918**
Annual income	0.061	0.604996^{NS}
Economic motivation	(-) 0.121	1.20671^{NS}
Risk bearing ability	0.230	2.339607*
Extension Contact	0.793	12.88**
Mass Media Exposure	0.412	4.47**

**Significant at the 0.01 level of probability;
*Significant at the 0.05 level of probability;
NS indicates Non significant;
Degrees of freedom (df) = 98

CONCLUSION

Most of the farmers showed favourable perception on disaster risk mitigation practices and believed that stated mitigation practices are useful for farming during extreme weather events. Adaptive capacities of farmers and rural youth can be improved with disaster risk mitigations practices to face the challenges of farm disaster through skill-oriented training and increasing the extension contact and mass media exposure. Appropriate agricultural technology interventions suited for hazards affected areas may be planned keeping in view the farmers' low annual income, marginal to small size operational land holding and favourable perception on technologies.

REFERENCES

Adesina, A.A. and Zinnah, M. (1993). **Technology characteristics, farmers' perceptions and adoption decisions: A tobit model application in Sierra**

Leone. *Agril. Eco.,* **9** (4): 297-311

Azman, A.; Silva, J.L.D.; Samah, B.A.; Man N. and Shaffril, H.A.M. (2013). Relationship between attitude, knowledge, and support towards the acceptance of sustainable agriculture among contract farmers in Malaysia. *Asian Soc Sc.,i* **9**(2):99–105

Burton, R.J.F. (2004). Reconceptualising the 'behavioural approach' in agricultural studies: a socio-psychological perspective. *J Rural Stud.,* **20**(2):359–371

Cramerer, C.F. and Loewenstein, G. (2004). Behavioural economics: past, present, and future. In: Cramerer CF, Loewenstein G, Rabin M (eds) Advances in Behavioral Economics. Princeton University Press, New York, pp 3–51

Datta, S. and Mullainathan, S. (2013). Behavioral design: a new approach to development policy. Center for Global Center. CDG Policy Paper. 16 (November)

Doss, C.R. and Morris, M. (2000). How does gender affect the adoption of agricultural innovations? The case of improved maize technology in Ghana. *Agril. Eco.,* **25**(1):27–39

FAO (2019). Disaster risk reduction at farm level: Multiple benefits, no regret. Rome.160 pp

FAO (2018c). The impact of disasters and crises on agriculture and food security 2017. 168 pp.www.fao.org/

Feder, G.; Just, R.E.and Zilberman, D. (1985). Adoption of agricultural innovations in developing countries: a survey. *Eco. Dev. Cult. Chang.,* **33**(2):255–298

Garforth, C.; Rehman, T.; McKemey, K.; Tranter, R.; Cooke, R.; Yates, C.; Park, J. and Dorward, P. (2004). Improving the design of knowledge transfer strategies by understanding farmer attitudes and behavior. *J, Farm Manag.,* **12**(1):17–32

Kivlin, J.E. and Fliegel F.C. (1967). Differential perceptions of innovations and rate of adoption. *Rural Socio.*, **32** (1):78-91

Kumari, N.; Bara, N.; Jha, B.K.; and Kumar, R. (2020). Farmer' Perception about Climate Change and its Association with Socio-economic Attributes in Ranchi, Jharkhand. *Indian Res. J. Ext. Edu.*, **20** (2&3):103-105

Lapar, M.L.A. and, Ehuri, S.K. (2004). Factors affecting adoption of dual-purpose forages in the Philippine uplands. *Agric Syst*., **81**(2):95–114

Manjusree, R.V.; Maiti, S.; Garai, S.; Jha, S.K. and Kadian, K.S. (2022). Farmers' perception towards agromet advisory services in Kerala. *Indian Res. J. Ext. Edu.*, **22** (2):34-37

OECD/FAO (2021). Building agricultural resilience to natural hazard-induced disasters: Insights from country case studies, OECD Publishing, Paris, *https:// doi.org/10.1787/49eefdd7-en*.

Prager, K. and Posthumus, H. (2010). Socio-economic factors influencing farmers' adoption of soil conservation practices in Europe,T.L. Napier (Ed.), Human dimensions of soil and water conservation, number January chapter 12, Nova Science Publishers Inc, New York (2010), pp. 203-223

Rehman, T.; McKemey, K.; Yates, C.M.; Cooke, R.J.; Garforth, C.J.; Tranter, R.B.; Park, J.R. and Dorward, P.T. (2007). Identifying and understanding factors influencing the uptake of new technologies on dairy farms in SW England using the theory of reasoned action. *Agric Syst.,* **9**4(2):281–293

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CERTIFICATE
OF PARTICIPATION

Azadi Ka Amrit Mahotsav

DEPARTMENT OF BIOTECHNOLOGY
Ministry of Science & Technology
Government of India

Bio-NEST

NATIONAL SEMINAR ON CONSERVATION OF BIODIVERSITY (NSCB 2022)

September 2 - 3, 2022

This is to certify that Prof./Dr./Mr./Mrs /Ms. I. Barman
of Dept. of Agricultural Extension, UBKV, Cooch Behar, West Bengal presented a paper titled Assessing Farmers' Perception on Disaster Risk Mitigation in Assam and authored by I. Barman and K. Pradhan
in ORAL/POSTER mode during NSCB 2022 at NEHU, Tura Campus, Meghalaya conducted under the aegis of Biotech KISAN Hub, North-Eastern Hill University, Tura Campus, Meghalaya funded by DBT, New Delhi.

Given this on the Third Day of September, Two Thousand and Twenty Two.

03.09.2022
DATE

(A Barman)
Organizing Secretary
NEHU, Tura Campus
SIGNATURE

(Fr. B Mukhim)
Principal
Don Bosco College, Tura
SIGNATURE

(S Gurudev)
Campus In-Charge
NEHU, Tura Campus
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BODOLAND INTERNATIONAL KNOWLEDGE FESTIVAL, 2023, INDIA

(27th February to 2nd March, 2023)

Bodoland Territorial Region Government
&
Bodoland University, Kokrajhar, India

CERTIFICATE

Certified that Prof./Dr./Sri/Smt./Km **Indrajit Barman** of **Uttar Banga Krishi Viswavidyalaya, Cooch Behar, West Bengal.**attended the Bodoland International Knowledge Festival, 2023 held under the auspices of Bodoland University, Kokrajhar. He/ She presented Research Paper(s) in the technical session, under the theme **Sustainable Agriculture**

Title of the paper: Assessing Farmer's Agricultural Extension Needs for Disaster Resilience in Flood Prone areas of North Bank Plain Agro-Climatic Zone of Assam

Mode of Presentation: Poster

Theme Coordinator
BIKF, 2023

Conference chair
BIKF, 2023

Registrar
Bodoland University

Vice Chancellor
Bodoland University