Economics of Elephant foot yam (*Amorphophallus paeoniifolius*) under natural and conventional cultivation in District Bilaspur (H.P.)

THESIS

By

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(A-2019-30-005)

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(AGRICULTURAL ECONOMICS)

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CERTIFICATE – I

This is to certify that the thesis entitled **"Economics of Elephant foot yam (*Amorphophallus paeoniifolius*) under natural and conventional cultivation in District Bilaspur (H.P.)"**submitted in partial fulfillment of the requirements for the award of the degree of **Master of Science (Agriculture)**in the discipline of **Agricultural Economics** of CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur is a bonafide research work carried out by **Mr. Prashant Thakur (A-2019-30-005)**son of **Shri Rajesh Thakur**under my supervision and that no part of this thesis has been submitted for any other degree or diploma.

This assistance and help received during the course of this investigation have been fully acknowledged.

Place: Palampur
Dated:

(Dr. Manoj Gupta)

Major Advisor

CERTIFICATE- II

This is to certify that the thesis entitled **"Economics of Elephant foot yam (*Amorphophallus paeoniifolius*) under natural and conventional cultivation in District Bilaspur (H.P.)"** submitted by **Mr. Prashant Thakur (A-2019-30-005)**son of **Shri Rajesh Thakur**to the CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur in partial fulfillment of the requirements for the degree of **Master of Science (Agriculture)** in the discipline of **Agricultural Economics** has been approved by the Advisory Committee after an oral examination of the student in collaboration with an External Examiner.

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Place: Palampur

Dated: ***(Prashant Thakur)***

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LIST OF ABBREVIATIONS AND SIGN USED

Sr. No.	Abbreviation	Meaning
1.	%	per cent
2.	/	Per
3.	₹	Indian Rupee
4.	CF	Conventional Farming
5.	EFY	Elephant foot yam
6.	et al.	et alii (and others)
7.	Fig.	Figure
8.	FYM	Farm Yard Manure
9.	ha	Hectare
10.	hrs.	Hours
11.	IFFCO mixture	Indian Farmer's Fertilizer Co-operative
12.	IR	Irrigated
13.	kg	Kilogramme
14.	ltr.	Litre
15.	MT	Metric Tonnes
16.	No.	Number
17.	P	Page
18.	PK3Y	*Prakritik Kheti Khushhal Kisan Yojana*
19.	q	Quintal
20.	SPNF	Subhash Palekar Natural Farming
21.	t	Tonne
22.	UIR	Unirrigated
23.	viz.	videlicet (namely)
24.	ZBNF	Zero Budget Natural Farming

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ABSTRACT

The study is based on primary data obtained using a two-stage random sampling technique from 61farmers, practicing Conventional Farming (CF) and Subhash Palekar Natural Farming (SPNF), in 8 villages of Bilaspur district of Himachal Pradesh. About one tenth of the total cropped area was under elephant foot yam crop in conventional and SPNF farms. The productivity of elephant foot yam was 307.73 q/ha and 305.28 q/ha in CF and SPNF, respectively. The total cost of cultivation of elephant foot yam was ₹ 3, 11,585 per ha in CF against ₹ 3, 17,384 in SPNF. In elephant foot yam cultivation, weeding was the major labour intensive operation accounting for 61.68 per cent in CF and 49.76 per cent in SPNF of total labour. In CF, The gross return of ₹ 9, 23,177 per ha and ₹ 9, 15,853 per ha were realized from CF and SPNF, respectively. Output input ratio was worked out to be 2.96 and 2.89 in CF and SPNF, respectively. In CF, the marketed surplus was found to be 54.05 quintals, whereas in SPNF, it was 45.16 quintals. In elephant foot yam marketing, the Producer-Wholesaler-Retailer-Consumer channel (Channel-IV) emerged as the most crucial channel, followed by the Producer-Trader-Consumer channel (Channel-III) for disposal of both CF and SPNF produce in the study area. It was found that producer share in the channel-IV and channel-III was 74.32 per 87.13 per cent, respectively. The problem regarding absence of the package of practices of elephant foot yam crop, attack by animals, no premium rate for SPNF produce and distantly located markets were found to be major production and marketing constraints confronted by farmers in the study area. Introduction of improved varieties, certification and processing of SPNF produce can lead to popularization of natural farming of elephant foot yam cultivation in the state.

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1. INTRODUCTION

1.1 The background

The role of agriculture in the growth of the Indian economy and overall national development hardly needs any elaboration. The agriculture sector remains a dominant sector in the Indian economy as it has sizable share both in employment generation and the gross domestic product (GDP). The resilience of Indian agriculture sector can be seen from the fact that despite the COVID-19 pandemic, its performance in output was substantial and came up with a robust growth rate of 3.4 per cent 2020-21 (Anonymous, 2020).

However, need is being felt for transformational change and re-orientation of Indian agriculture in the light of new challenges and opportunities. Presently, agriculture is exposed to three of the most significant challenges of the 21st century i.e., sustaining food and nutrition security, adaptation and mitigation of climate change, and sustainable use of critical resources such as water, energy, and land. Food and Agriculture Organization (FAO) in April 2018 has also urged all countries to move towards the adoption of agro-ecology to meet the twin goals of global food security and conservation of the environment.

Natural Farming practices perfectly synchronize with the principles of agro-ecology and it is a holistic alternative to the present high-cost chemical inputs-based agriculture. Its greatest strength is that it is based on the latest scientific discoveries in agriculture, and, at the same time, it is rooted in Indian tradition. Natural Farming is altogether different from organic farming as it discourages externally sourced inputs and centered on indigenous cow dung-urine cultures.

The Government of Himachal Pradesh (GoHP) has implemented a flagship program, *'Prakritik Kheti Khushhal Kisan Yojana*' (PK3Y), from 2018 to double farmers' income as envisioned by Sh. Narender Modi, Hon'ble Prime Minister of India. It aims to

produce food grains, vegetables, and fruits through non-chemical locally sourced inputs and enhance farmer's income by sustaining crop productivity and minimizing the cost of cultivation through a cost-effective and climate-resilient farming system. The scheme invests heavily in building the capacities of farmers and their continuous hand-holding.

The crucial innovation and strength of the project is the farmer-to-farmer knowledge dissemination strategy. This Yojana aims to sustain the farming of mountainous smallholders through the spread of Zero Budget Natural Farming (ZBNF). ZBNF has been renamed as Subhash Palekar Natural Farming (SPNF) in Himachal Pradesh to honour its founder Padamshri Sh.Subhash Palekar. SPNF is an emerging agro-ecological practice that has spread in India as a form of agricultural system focusing on transformation rather than management of an existing system. Farmers actively steward biodiversity to create systems capable of sponsoring their soil fertility, crop protection, and yield constancy.

1.2 Tuber crops in India

Tuber crops are the third most important food crops, after cereals and legumes. Cassava, sweet potato, elephant foot yam, aroids; and a few other tuber crops are major tropical tuber crops being cultivated in India (Swadija et al., 2016). These can be produced with very low inputs and are broadly used as vegetables and are rich in dietary fiber and carotenoids. These crops possess higher biological efficiency as food producers and show highest rate of dry matter production per day per unit area among all the crops (Ray et al., 2009).These crops are valued for their high starch content and sizeable portion is used for industrial purposes as they have unrealized potential for processing into high end products for food, feed and industrial uses (Krishnakumar and Sajeev, 2020). Tuber crops play an essential role in the food security of small and marginal farmers.

Elephant foot yam (*Amorphophallus paeoniifolius***)** is an important tuber crop that is mainly grown throughout South and South East Asia, China, New Guinea, Northern

Australia, Fiji, and Samoa. Elephant foot yam has been grown in Asia and the Indo-pacific area for millennia.(Romand-Monnier, 2013).

In India, Elephant foot yam is mainly cultivated in Andhra Pradesh, West Bengal, Gujarat, Kerala, Tamil Nadu, Maharashtra, Uttar Pradesh, and Jharkhand, etc. This crop is also grown as an intercrop in India, with banana and coconut. The elephant foot yam cultivation gained momentum in India after introduction of corms of a new non-irritant smooth type variety Gajendra. In India, it is being cultivated on an area of 33,000 ha, with a production of 801,000 MT (Anonymous, 2020a). It is mainly grown in *Kharif* season and it takes around eight to nine months to complete its life cycle. As a tropical tuber crop, it grows well in hot (25-30°C) & humid (80-90 % R.H.) climates with a well-distributed annual rainfall of around 1000-1500 mm. Elephant foot yam plants flourish well in medium to light soils (coarse-textured sandy soils) with ample amounts of organic matter because they prefer well-aerated soils.

1.3 Elephant foot yam cultivation in Himachal Pradesh

Himachal Pradesh is a hilly state, with more than 80 percent of farmers having small and marginal landholdings. The state has limited irrigation infrastructure and the hilly terrain further limits the expansion of irrigation facilities. Monkey menace is also emerging as a big challenge in many parts of the state and has forced many farmers to give up farming (Reddy and Chander, 2016). The state government is consistently aiming to increase the farming income without adversely impacting the state's ecology. Therefore, there is an urgent need to explore various cropping options to overcome above mentioned bottlenecks and ensure the sustainable agricultural growth, increased income levels and better employment avenues for the farmers.

The state has a comparative advantage in cultivating many vegetable crops and elephant foot yam (*Jimikand*) is one such viable and remunerative cash crop to overcome the above-mentioned bottlenecks. Besides, this crop has emerged as one of the few viable crop alternatives for monkey menace affected areas. Elephant foot yam offers excellent

scope for adoption in low and mid-hill zones of the state due to its high productivity and popularity as a vegetable in various local delicious cuisines.

Agriculture is the mainstay of the more than 80 per cent population in Bilaspur district (Anonymous, 2020b). The area under vegetable crop has grown significantly (3554 ha) in the district during the last decade, district has achieved production level of 94641 tonnes (Anonymous, 2020c). Elephant foot yam is the farmers' major cash crop in Bilaspur of Himachal Pradesh and this district has emerged as major hub of elephant foot yam production in the state. Sizable elephant foot yam area was being sown every year in Bilaspur district and production level of 3698 tonnes was achieved from 86 ha elephant foot yam area in 2019-20 (Anonymous, 2020d). There is a massive demand in the neighboring states for elephant foot yam produced in district.

1.4 Rationale of the study

Elephant foot yam is emerging as a viable and remunerative cash crop alternative in the state but no scientific study has been yet conducted on economic aspect of this crop in the state. Therefore, economic aspect of Elephant foot yam farming needs to be documented and analyzed to guide the policymakers for promoting its cultivation in the other parts of the state. Hence, comparative study of natural and conventional elephant foot yam farming practices, entitled, "Economics of Elephant foot yam (*Amorphophallus paeoniifolius*) under natural and conventional cultivation in District Bilaspur (H.P.)" has been undertaken:

1.5 Objectives:

- To study the economics of Elephant foot yam under natural and conventional cultivation on different categories of farms
- To analyze the marketing of Elephant foot yam in the study area
- To examine the prospects of and constraints in the spread of Elephant foot yam crop in the state

The study will be helpful to the policymakers and planners to shape the policies for the socio-economic upliftment of Elephant foot yam growers. The study will be of great use to researchers in understanding the elephant foot production system in Himachal Pradesh. The study will also benefit the elephant foot growers by highlighting their problems and providing suggestions for their future betterment.

1.6 Presentation of findings and organization of the thesis

The entire study has been systematically presented and organized in different chapters. Chapter I (Introduction) highlights the importance of elephant foot cultivation along with the justification and the objective of the study. This is followed by Chapter II, which describes the comprehensive and systematic review of relevant research work done at the national and international levels. The scientific and systematic methodology adopted for selecting the sample, collection, and analysis of data has been elaborated in Chapter III. The study results have been documented and embroidered with logical conclusions and inferences under various sections/sub-T sections in Chapter IV. Finally, Chapter V summarizes the findings and portrays policy implications emerging from the study. The references quoted and used in this study have been listed under the head "Literature Cited." The illustrations, tables, and figures have been used to elucidate the results. In contrast, additional information has been given in appendices for more clarification and further use by interested researchers.

2. REVIEW OF LITERATURE

A critical and thorough insight of the already conducted studies relating to the topic "Economics of Elephant foot yam (*Amorphophallus paeoniifolius*) under natural and conventional cultivation in district Bilaspur" with respect conceptual clarity and methodological issue is essential. It highlights the limitations of research work done in the past, clarifies the concepts, and helps in formulating the methodology of the study. This critical reviewing involves locating, reading, and evaluating reports of research as well as reports of casual observation and opinions of experts related research project. In this view, the review is done very extensively and review of literature has categorized into the following main headings:

2.1 Economic analysis, production and technological gaps
2.2 Marketing system, its problems and constraints
2.3 Importance and economics of natural farming
2.4 Comparative analysis among conventional and natural farming

2.1 Economic analysis, production and technological gaps

Clark et al. (1998) conducted a study on agronomic, economic, and environmental comparison of pest management in conventional and alternative tomato and corn systems in northern California. The results showed that pesticide reductions in tomatoes would be economically costly due to the dependence on hand hoeing as a substitute for herbicides. Based on the performance of the low-input and organic tomato systems, 50 per cent pesticide reduction would increase average pest management costs by 50 per cent.

Brumfield et al. (2000) analyzed comparative cost of conventional integrated crop management and organic methods. Results showed that integrated crop management systems (ICM) are more profitable than conventional and organic systems. Organic systems had the lowest net returns; however, the net returns were reasonably close to

conventional and integrated crop management system (ICM) systems because of the organic price premium.

Srinivas and Ramanathan (2005) estimated the cost of cultivation, farm income measures and resource-use efficiency of the elephant foot yam crop in Andhra Pradesh, Tamil Nadu, and Kerala. The study has indicated the total cost of cultivation as ₹ 1, 73,105, ₹ 93,450, and ₹ 1, 68,032 per ha in Kerala, Andhra Pradesh, and Tamil Nadu, respectively. The benefit-cost ratios are 1.38, 1.38, and 1.50 for elephant foot yam cultivation in Kerala, Andhra Pradesh, and Tamil Nadu, respectively. The study revealed excessive use of all NPK fertilizers in Kerala.

Venkatram et al. (2007) conducted a study to analyze the various factors influencing the production and marketing of elephant foot yam in the Salem district of Tamil Nadu. The results revealed that labor, seed and fertilizer were significantly influenced the crop production. The high incidence of disease, non-availability of quality seed material, scarcity of skilled labor in the cultivation of elephant foot yam and inadequate technical advice were the significant production constraints. Low price, lack of market information at consumption points, less knowledge on value addition, postharvest handling and absence of grades were some of the marketing problems faced by the elephant foot yam cultivators.

Gopinath et al. (2008) evaluated the comparative performance of five varieties of bell pepper (*Capsicum Annuum* L.) and changes in soil properties under organic and integrated nutrient management (INM) systems in Uttrakhand. The yield of bell pepper varieties grown with organic manures reduced by about 22 per cent compared with that of integrated nutrient management (INM) systems. At least a 25–50 per cent price premium for organic bell pepper may be required to offset the higher cost of cultivation and low yields under an organic production system compared with an integrated crop management system.

Mukhopadhyay et al. (2008) conducted a study to find suitable intercrop for elephant foot yam. They found that growth parameters viz., the height of pseudostem, pseudostem girth and canopy spread were superior when elephant foot yam was grown as a pure crop followed by vegetable cowpea grown as an intercrop.

Nedunchezhiyan et al. (2008) assessed the yield potential and economics of elephant foot yam (*Amorphophallus paeoniifolius*) + green gram (*Vigna radiata*) intercropping system as influenced by mulching and fertilizer levels. The study showed that the application of 2 tonnes per ha dried farm waste as mulch increased elephant foot yam yield by 21.6 per cent over the no mulch. The maximum gross return (₹ 1, 07,575) was obtained with the application of N: P: K @ 120:90:120 kg per ha along with mulching. The benefit cost ratio analysis revealed that the maximum benefit cost ratio was found with the application of N: P: K @ 80:60:80 kg per ha along with mulching (2.02).

Ramanandam et al.(2008) found that the conjoint use of organic manures, biofertilizers and inorganic fertilizers significantly influenced growth, dry matter production and tuber yield of cassava. The application of the recommended dose of NPK fertilizers, vermicompost and *Azospirillum* resulted in substantially higher growth attributes and maximum dry matter production and tuber yield.

Suja and Sundaresan et al. (2008) reported as the organically produced corms had slightly higher dry matter, crude protein and starch contents and possesslower oxalate content.

Anonymous (2009) studied the impact of organic farming on farm incomes, incomes of landless labor, consumer satisfaction, export, etc. The factors contributing to the net economic gain were the yield, price, cost of cultivation and area shift. Interestingly, the contribution of yield was negative to the tune of ₹ 3022 per acre in plains and ₹ 629 in hilly areas. The effect of price increase was ₹ 2038 and ₹ 1899 per acre in plain and hill areas, respectively. The cost reduction could exert a positive impact

to the extent of ₹ 790 and ₹ 268 and area shift by ₹ 957 and ₹ 583, respectively. The corresponding economic benefit amounted to ₹ 762 and ₹ 2121 per acre or ₹ 5791 and ₹ 6787 per farm. Thus, farm income increased by 3.80 per cent in plain and ₹ 13.55 per cent in hilly areas. Higher benefit in hill areas was due to the predominance of traditional crops, which gained on many counts.

Ravi et al.(2009) conducted a study on the growth and productivity of elephant foot yam (*Amorphophallus paeoniifolius* (*Dennst. Nicolson*) and found that Gajendra, SreeAthira (a hybrid), Bidhan Kusum and NDA-9 are some of the high yielding *Amorphophallu*s varieties released for cultivation in India. The production potential of this crop is 50-80 tonnes per ha, and the net return was over ₹ 1 lakh per ha. The plant growth and corm yield were influenced by the size of planting material (corms/cormels/corm pieces), plant spacing and nutrient management. However, the production aspect of this crop was less understood as scanty research has been carried out on this crop.

Janaki and Murugan (2010) conducted a study among the tapioca growers in the Salem district. They found that among the several constraints marketing constraints like exploitation by middle man (88.33%), malpractices in point scale fixation (86.66%), lack of regulated market (83.33%), low price for tubers due to fluctuations in price (80%) followed by production constraints like mosaic and tuber rot diseases (83.33%), labor scarcity (80.00%), unavailability of quality planting materials (73.33%) and lack of short duration varieties (68.33%) were the significant constraints in tapioca production.

Patel et al. (2010) conducted a study on integrated nutrient management (INM) in elephant foot yam and revealed that the maximum yield of corm in elephant foot yam could be obtained by the application of 75 per cent RDF (through inorganic source)+25 per cent RDF (through organic source) 5 kg AMF per ha +5 kg *Azospirillum* per ha.

Saravaiya et al.(2010) conducted a study on the influence of integrated nutrient management (INM) on growth and yield parameters of elephant foot yam under south

Gujarat condition. In elephant foot yam, the application of 100 per cent RDF + *Azospirillum*5 kg per ha+ PSB 5 kg per ha was proved to be beneficial in connection with corm yield (55.33 t/ha) which was at par with the treatment of T4 and T1. The reason was that the application of FYM might have enhanced soil microflora activity besides supplementing both macro and micronutrients.

Ganesh (2010) researched to analyze the economic aspects of organic farming in selected organic villages of North Karnataka. The results revealed that the FYM and vermicompost together accounted for 68 per cent of the total input cost in organic farms. In contrast, the cost of fertilizers and pesticides accounted for a significant share (67.00%) in conventional farms. The annual input cost of organic farms was 15.39 per cent less as compared to a conventional farm.

Naik (2010) analysed the comparative economics of vegetable production under organic and inorganic farming in the Belgaum district of Karnataka. The results of decomposition analysis showed that the adopters of organic farming technology produced 14.88 per cent higher income from tomato production than inorganic farming adopters. Similarly, 27.07 per cent higher income was realized from chilli production by organic farming adopters than inorganic farming adopters.

Suja et al. (2010) assessed on-farm validation of organic farming technology in elephant foot yam in Kollam and Pathanamthitta districts of Kerala. Organic farming resulted in higher corm yield (34-60 t/ha) and additional income (₹. 43,651/ ha) over conventional farming. Organically produced corms had a significantly higher dry matter and Mg contents and significantly lower oxalate content. Organic farming generated ₹ 1, 13,720 per ha and a benefit cost ratio of 1.49 against ₹ 70,069 per ha and 1.40 respectively under conventional farming. Organic farming generated an additional income of ₹ 43,651 per ha over conventional farming.

Byju et al. (2011) reported that elephant foot yam in India was being cultivated in Andhra Pradesh, West Bengal, Gujarat, Kerala, Tamil Nadu, Maharashtra, Uttar Pradesh,

and Jharkhand. Sree Padma, Gajendra, SreeAthira (a hybrid), Bidhan Kusum and NDA-9 are some high-yielding *Amorphophallu*s varieties released for cultivation. The corm production potential of this crop is 50- 80 t/ha, and the net return was about ₹ 1, 42,725-₹ 2,14,087 per ha.

Kassali (2011) studied Sweet potato [*Ipomoea batatas* L. (Lam)] and concluded based on cost and returns analysis that labor accounted for 68 per cent of the total cost of production and that sweet potato production was profitable. The yield had a more significant impact on profitability and capital inputs had the most negligible effect in reducing profit. Fertilizers and transportation were underutilized; rent, farm implements, planting material, chemicals and labor were overused. An increase in the scale of sweet potato production, more capital inputs and an increase in yield can improve efficiency in sweet potato production

Murthy et al. *(*2011) reported that the conjunctive use of 75 per cent of inorganic fertilizers and 25 per cent of organic manures along with Arbuscular Mycorrhizal Fungi (AMF) and *Azospirillum* (5 kg/ha each) recorded highest corm yield of 51.80 t/ha significantly compared to absolute control (34.33 t/ha) in elephant foot yam whereas, a combination of 75 per cent of inorganic fertilizers and 25 per cent of organic manures along with PSB (5 kg/ha each) gave highest vegetative growth. The benefit cost ratio is high for the treatment of 75 per cent of inorganic fertilizers and 25 per cent of organic manures along with arbuscular mycorrhizal fungi and *Azospirillum* (5 kg/ha each) than the application of inorganic alone.

Nagaraja (2011) conducted a study in Karnataka with an overall objective of inquiring into the production and marketing of organic rice cultivation viz-à-viz conventional rice cultivation. The results revealed that organic rice cultivation incurred higher expenditure than conventional rice, but the cost of production worked out to ₹ 557 per quintal was indicating cost-effectiveness of producing organic rice.

Suja et al. (2011) studied higher yield, profit, and soil quality from the organic farming of elephant foot yam. They reported that organic farming favored canopy growth, corm biomass and lowered collar rot disease.

Kondaguri (2012) conducted a study in Karnataka on farmers growing paddy under organic farming and inorganic farming. The results of decomposition analysis showed that the adopters of organic farming technology produced 5.52 per cent higher income from paddy production than adopters of inorganic farming.

Sahu and Koshta (2013) concluded that the average size of holding of colocasia growers was 2.77 ha in Kabirdham district, Chattisgarh. The overall cropping intensity of the sample farm was 227.80 per cent. The cost of cultivation of colocasia was ₹48515.10 per ha, which was conceded by the labour cost with 49.08 per cent requiring 268.31 man-days for performing operations of colocasia cultivation. The overall yield of colocasia was 96.54 quintal per ha and gross return was obtained at ₹170671.29 per ha. On average, the B:C ratio was 2.52 with an average net return of ₹122156 per ha. Out of the total production 92.39 per cent of colocasia was used as marketable surplus.

Singh et al. (2013) analysed acridity reduction and value addition of elephant foot yam grown in Bilaspur district of Himachal Pradesh. Researcher found that among different treatments, the lowest oxalate content was observed when cubes were treated overnight in 5 per cent sodium bicarbonate solution followed by a further overnight dip in 2.5 per cent citric acid solution and fried to a golden brown color.

Suja (2013) researched comparison of tuber yield, nutritional quality and soil health under organic versus conventional production in elephant foot yam. The study showed that organic management resulted in a significantly higher yield of 20 per cent over conventional practice (47.61 t/ha) in elephant foot yam. The study also showed an increase in N, P, K content along with higher organic C. It also results in higher dry matter of organic corm.

Anonymous (2014) conducted a survey among the farmers in two districts, viz., Nadia and 24 North Parganas of West Bengal, on adopting recommended cultivation practices of elephant foot yam . It was observed that farmers met their seed requirement only partially from their products and depended on traders and other sources for the rest. A significant portion of their produce was being sold and none of the farmers used their products for any processing.

Nedunchezhiyan (2014) assessed the production potential of intercropping spices in elephant foot yam (*Amorphophallus paeoniifolius*). The study showed that all the intercropping systems except elephant foot yam+ turmeric (1:2) fetched higher gross and net returns compared to sole cropping of elephant foot yam, ginger and turmeric. The highest gross and net returns were noticed in elephant foot yam + ginger (1:2) followed by elephant foot yam + ginger (1:1) and elephant foot yam +turmeric (1:1). The highest benefit cost ratio was observed in elephant foot yam + ginger (1:2) followed by elephant foot yam + ginger (1:1). The study revealed that elephant foot yam + ginger (1:2 additive series) may be recommended for higher profit. Elephant foot yam + turmeric (1:2 additive series) may be recommended, where collar rot was a problem.

Sahoo et al. (2014) conducted a study on the effects of organic and inorganic fertilizers on the yield of elephant foot yam and soil enzymes activity. The highest leaf area per plant was recorded with the application of farm yard manure (FYM) 25 tonnes per ha and FYM 10 tonnes per ha with NPK@ 100-60-100 kg per ha. These treatments also resulted in a higher light interception and offered lower soil resistance. The application of FYM 10 tonnes per ha + NPK@ 100-60-100 kg per ha and farm yard manure (FYM) 25 tonnes per ha had produced 105.70 per cent and 97.10 per cent higher corm yield, respectively, over control. These treatments maintained higher soil enzyme activities despite poor post-harvest soil nutrient status.

Singh (2014) assessed the yield and economics of elephant foot yam sown with bottle gourd, ridge gourd and bitter gourd under a multilayer vegetable cropping system. The yield of corms (376.07 q/ha) was observed highest in the sole crop of elephant foot

yam followed by elephant foot yam + bitter gourd, while the maximum net return (Rs. 377673/ha) and income per rupee investment (2.17) was observed in the elephant foot yam when it was grown with bitter gourd. The results clearly indicated that the bitter gourd could be profitably intercropped with the elephant foot yam.

Suja and Sreekumar (2014) conducted a study on implications of organic management on yield, tuber quality and soil health in yams in the humid tropics with an aim to proximate composition and mineral content of tubers and soil physicochemical and biological properties in three species of *Dioscorea* (white yam: D. *rotundata*, greater yam: D. *alata* and lesser yam: D. *esculenta*. Organic farming (20.34 t/ha) produced a significantly higher yield over conventional practice (18.64 t/ha) by 9 per cent. All the species responded well to organic management, which lowered the bulk density and particle density slightly and improved the water holding capacity (15.00%) of soil. Tuber quality was enhanced with significantly higher Ca (72.67 m/ 100g), slightly higher dry matter, crude protein, K, and Mg contents. Organic plots showed significantly higher available K, by 34 per cent, and pH, by 0.46 units, and higher soil organic matter by 14 per cent. Thus, organic farming was an eco-friendly management strategy in yams for a sustainable yield of quality tubers besides maintaining soil health.

Bender et al. (2015) studied the effect of growing systems on the quality of carrots. The study showed that the marketable yield of organic carrots was 8 percent lower than conventional carrots. Conventional carrots contained pesticide residues and had significantly higher nitrate concentrations than organic carrots. The contents of total sugars, phosphorus, potassium, calcium and magnesium did not differ considerably between carrots from different cultivation systems. The dry matter content of organically grown carrots was substantially higher at harvest, whereas vitamin C and ß-carotene content were significantly lower in organically grown carrots. However, after 5-months of storage, the organic carrots had substantially higher total soluble solids (TSS) and β-carotene content than the conventional ones indicating that organically grown carrots were less susceptible to storage conditions.

Byju et al. (2016) studied fertilizer best management practices by site-specific nutrient management (SSNM) and customized fertilizers for elephant foot yam (*Amorphophallus paeoniifolius)* cultivation in India. The results of the study showed good agreement between predicted and measured corm yields during the four years, which indicated that the calibrated model could be used to improve NPK fertilizer recommendations for elephant foot yam in India. Based on the results and using soil fertility maps and agro-ecological unit maps, site-specific nutrient management (SSNM) zonation maps and secondary and micronutrient fortified customized fertilizers were developed for significant elephant foot yam growing environments of India.

Jyothi et al. (2016) conducted a study on the response of varieties of elephant foot yam to organic management. Experiments showed a significant improvement in soil pH and bacterial count, slight lowering of bulk density and particle density, improvement in water holding capacity, secondary and micronutrient status, N fixers, and dehydrogenase enzyme activity in the organic system.

Nedunchezhiyan (2016) assessed drip irrigation and fertigation effects on corm yield, water and fertilizer use efficiency and economics in elephant foot yam (*Amorphophallus paeoniifolius*). The highest corm yield (37.0 t/ha) was obtained due to drip irrigation at 100.00 per cent CPE and fertigation of N-K2O @ 120–120 kg per ha. However, the maximum water-use efficiency (WUE) was recorded with drip irrigation at 80 per cent CPE and fertigation of N-K2O @ 120-120 kg per ha. This treatment resulted in optimum corm yield (35.7 t/ha) with a net saving of 4,341,000 liters (434.1 mm) of water/ha of land/season, net income of 154 × 103 ₹/ha and net profit ₹ 701 per mm of water applied.

Keesecker et al. (2017) conducted a study on value chain assessment of elephant foot yam production in southern Chin state in Myanmar. The study identified various causes which limited the income from elephant foot yam. The study showed the primary opportunities to boost revenue from elephant foot yam production lies in increasing value in the value chain through product improvements rather than capturing more of the value

already existing within the value chain. The study identified several short-term (1 year) and long-term (3-5 year) interventions for improving the income of elephant foot yam growers.

Makowski et al. (2017) analyzed yield variability in organic versus conventional horticulture and showed that yields in organic horticulture were on average 10 to 32 per cent lower than yields in conventional horticulture. The analysis further revealed a substantial variability of organic versus conventional yield ratios across experiments. The probability of getting extremely high yield loss in organic systems was small, and yield losses have only a 10 per cent chance to exceed 50 per cent of conventional yield.

Nedunchezhiyan et al. (2017) researched organic sources of nutrients affecting the growth, yield and quality of elephant foot yam (*Amorphophallus paeoniifolius*). Application of 10 tonne/farm yard manure (FYM) along with 5 tonne ash, 5 kg *Azospirillum*, and 5 kg phosphorus solubilising bacteria (PSB) per ha (T7) resulted in significantly taller pseudostem, more girth of pseudostem at collar region, more expansive canopy, more leaflets per hill and leaf area at 3 and 5 months after planting(MAP). Plants under the same treatment had a maximum dry matter in pseudostem, leaf canopy and corm, and corm yield. Application of PSB resulted in more excellent dry matter production and corm yield than vesicular arbuscular mychorrihzae. Farm yard manure based organic source of nutrients significantly reduced calcium oxalate in corms.

Jata et al. (2018) conducted a field experiment on intercrop and drip irrigation effects on growth, yield, water-use efficiency and economics of elephant foot yam (*Amorphophallus paeoniifolius*). The result revealed that the cost of cultivation in elephant foot yam + green gram intercropping was 4 per cent higher than sole elephant foot yam. The increase in net return under intercropping was 16.9 per cent over sole elephant foot yam. Elephant foot yam intercropped with green gram resulted in a significantly higher B: C ratio than sole elephant foot yam. The cost of cultivation was lower in surface irrigation than drip irrigation. The highest net return was noted with drip

irrigation at 100 per cent cumulative pan evaporation (CPE), being on a par with drip irrigation at 80 per cent cumulative pan evaporation (CPE). The B: C ratio under surface irrigation was significantly lower than all the levels of drip irrigation.

Jogi et al. (2020) conducted a study on the impact of front-line demonstration on yield and economics of elephant foot yam (*Amorphophallus paeoniifolius*) in the Mungeli district Chhattisgarh. The study showed a wide gap between scientific practices and conventional practice in cultivating elephant foot yam. The front-line demonstration programme effectively changed the attitude, skill and knowledge of farmers regarding recent technology innovating in different research stations. The study's outcome revealed that the average maximum demonstration practice yield was recorded 346 quintals per ha, whereas, in farmers' practice, the result was 236 quintals per ha. The percent increase in yield over farmers' practices was recorded at 49.47. The average technology and extension gap were computed at 220.50 quintals per ha and 118 quintals per ha, respectively. The demonstration gave a higher average net return of Rs. 923250 and B: C ratio was 2.84. The result showed that yield could be increased by adopting improved variety and recommended package of practices.

Kant et al.(2020) assessed the impact of varietal replacement demonstration on the yield and economics of elephant foot yam (*Amorphophallus paeoniifolius*) cv. Gajendra in Bhagalpur District of Bihar and revealed the higher average yield in the varietal replacement demonstration (595.5 q/ha) as compared to farmers' traditional practice (288.40 q/ha) adopted by the farmers. The percentage increase in the yield 106.48 over traditional practice was recorded. The technology gap and extension gap were computed at 159.35 and 307.10 quintals per ha, respectively, along with 48.11 percent of the technology index. The varietal replacement demonstration field gave a higher average net return of Rs. 587630 and B: C ratio was 1:5.22. The results of the study indicated the gap that existed in the potential yield and demonstration yield was due to soil fertility and weather conditions. Present results clearly show that the yield and economics of elephant foot yam can be boosted up by adopting recommended technologies.

Remya and Suja (2020) conducted a study on conservation agriculture in elephant foot yam (*Amorphophallus paeniifolius*) + banana (*Musa* AAB) system for higher productivity and profit. Conservation agriculture out yielded farmers' practice by 46.90 per cent concerning elephant foot yam yield and 4.20 per cent for banana yield. Among the varieties practices interaction, Sree Padma under conservation practice was the most effective (fresh corm yield and bunch yield of 23.10 t/ha and 31.70 t/ha, respectively). The conservation treatment proved to be the most productive (by 11.1 per cent over F.P.) and profitable (by 41.2 per cent over F.P.) as revealed from the highest tuber equivalent yield (75.8 t/ ha), production efficiency (252.6 kg/ha/day), gross income (₹2273615/ha), net income (` 1743 454/ha) and B: C ratio (4.3). Among the treatment combinations, the highest productivity (86.5t/ha) and profitability (net income of ₹ 2065307/ha; B: C ratio of 4.9) was realized from the Sree Padma variety of elephant foot yam intercropped with Nendran banana under conservation agriculture.

Singh et al. (2020) conducted a study on the effect of integrated weed management practices on weed dynamics, growth, yield, and economics of elephant foot yam [*Amorphophallus Paeoniifolius* (Dennst.) Nicolson]. Increase in corm yield, the net return, and B: C ratio compared to weedy check was to the tune of 8.83 to 146.24, 11.27 to 906.95, and 3.28 to 115.38 per cent, respectively. Significantly lowest weed population kept the competition for growth resources to the minimum by weeds. It ultimately resulted in the realization of an effective higher corm yield (41.54 t/ha), net return (Rs. 450521/ha), and B: C ratio (2.52).

2.2 Marketing System problems and constraints

Gopalan and Gopalan (1991) found that the agricultural marketing system in Tamil Nadu suffered from severe constraints like high costs, the existence of intermediaries, storage and transport bottlenecks and lack of market information among the farmers. The analysis suggested that the cooperatives had weakened the many small monopolies and malpractices of intermediaries and had led to a considerable improvement in marketing efficiency. However, the need was felt for timely and

adequate farm inputs, grading schemes and more efficient dispersal of information, among other requirements.

Rajput et al. (2001) suggested that adequate input facilities and timely supply of cheaper credit by the financing agencies to the producers, processors and traders would help increase the productivity and efficiency in the marketing of the produce. The result indicated that the price-spread of potatoes should be reduced to encourage the potato growers to sell their produce through cooperative marketing societies. The potato-based processing unit can play a significant role in fetching reasonable prices rather than selling the potato in the market. To improve the marketing of potato cold storage, facilities should be extended at the farmer level at cheaper rates.

Chauhan and Mehta (2002) conducted a study on problems and constraints in the vegetable market of Himachal Pradesh. The significant limitations reported by farmers were the lack of storage facilities, as reported by 94 per cent of vegetable growers. The other essential problems perceived by vegetable growers were road blockage due to landslides (71.0%), costly packing material (58.0%), expensive grading (56.0%), lack of pucca roads (41.0%), inadequately skilled labor for grading and scarcity of packing material (24.0%).

Jairath (2002) studied institutional reforms in Indian agricultural markets. The study showed that the system of the diversity of market fees, existence of wide variation in the rates of market fees and its imposition on the buyers/sellers in different types of crops produce and livestock along with the imposition of development fund, substantial market charges and entry tax inflated the cost of production and widened the gap between the consumer price and producer price.

Rajesh and Sundaresan (2002) studied the attitude of paddy farmers towards regulated markets and constraints concerning physical facilities at regulated markets in the Madurai district of Tamil Nadu. Many farmers reported that due to lack of owned transport facilities followed by lack of market information, the farmers were unable to

make the right storage decision. Also, they were not aware of the actual market conditions about price. The study showed that the majority of the farm products were disposed of at the farm gate to meet the immediate cash. More than 90 per cent of their marketable paddy surplus was sold immediately after harvest with practically no storage at all.

Pendnekar (2003) assessed the performance of the regulated market in Goa and revealed that during the peak seasons of marketing, the producer-sellers were observed to have been selling their produce at lower prices, and middlemen took advantage of the seasonal effect. Further, the godown facilities available in the Goa market were observed to be inadequate and delay payment even after 30 days, particularly peak seasons of marketing.

Sharma and Thakur (2004) examined the existing market infrastructure, its performance, limitations and made suggestions for improvements needed for smooth, orderly and efficient marketing of agricultural commodities in Himachal Pradesh. About transportation, the study found a weak correlation between production/marketed supplies of fruits or vegetables and road density. The use of the available markets was limited due to the problem of transport from villages to the market. It was also found that banking and communication facilities available in most of the markets were not used for the benefit of the farmers. In these circumstances, many producers took their products to the adjacent markets of Delhi, Punjab, and Haryana for sale. It was also found that the Haryana Agriculture Produce Market Committee successfully created competitiveness in the marketing of fruits through direct purchases and market intervention mechanisms. The study was on the negative side of agro-processing and it remained at the low level of development. It was pointed out that only 1.90 percent of fruits were processed and the figures for other crops were negligible.

Salam and Banafar (2005) analyzed the production and marketing of tuber crops in the Baster districts of Chhattisgarh. The study showed colocasia is a highly remunerative crop compared to other tuber crops. There were two marketing channels for

the marketing of tuber crops. Channel-I: Producer-Consumer; Channel-II: Producer – Village Merchant – Wholesalers – Retailers – Consumer. The most efficient marketing channel for tuber crops was channel-I, followed by channel-II. Producer's share in consumer's rupee was higher in channel-I. The primary constraints in the production of tuber crops were a lack of irrigation, technical knowledge, and resources. Lack of storage facilities was the major constraint in the marketing of Colocasia.

Onubuogu and Onyeneke (2012) examined the market orientation, market orientation strategies and determined the factors affecting market orientation in root and tuber crops production in Imo state, Nigeria. Majority of the farmers (45.00%) offered 31-40 per cent of their total production to market. The village market has the highest percentage (76.67%), where the root and tuber crop farmers sell their produce. The majority of root and tuber crop farmers (56.70%) marketed their products in raw and processed forms. About 41.70 per cent use a better storage method. Low production capital was the major constraint of the root and tuber crop farmers in Imo State and reported by 57 per cent farmers.

Ramakrishna and Anjjappa (2013) studied the problems and prospects of agricultural produce marketing committees in Bellary. The researcher found that increase in middlemen in the marketing of agricultural goods resulted in a decrease in the final payment of the farmers. The labor forces in the Agricultural Produce Market Committee (APMC) were suffering from adequate knowledge about the organizational structure and the schemes of the Government. At the same time, the dealers and commission agents were well organized and had an abundant knowledge about the operations of Agricultural Produce Market Committee (APMC). This had resulted in the inevitable dependence of the farmers and laborers on the commission agents and dealers about operations of Agricultural Produce Market Committee (APMC).

Vadivelu and Kiran (2013) overviewed problems and prospects of agricultural marketing in India. They revealed that farmers' awareness of different components of market information and its utility was inferior (11.0 to 37.00%) compared to that of

traders (75.00%). Out of farmers' expectations on grades, quality, prices in potential markets, price projections, only real-time arrivals and prices were documented and disseminated with the traditional approach. Hence, there is a need to create awareness among the farmers through the agricultural extension agencies like the state department of agriculture, Krishi Vigyan Kendras so that the marketing information on agriculture commodities were incorporated in the extension services along with production aspects to the farmers

2.3 Importance and Economics of natural farming

Babu (2008) examined the circumstances of farmers who practice zero-budget natural farming and the factors that led them to adopt this farming style. It was determined that the cost of cultivating crops such as paddy in one acre under natural farming was only about ₹ 5000-6000. As a result, farmers moved to natural farming on a shoestring budget. It was revealed that costs were considerably lowered and the procedure was relatively simple to implement.

Kumari and Sharma (2014) studied the influence of pesticides on farmer health in Kullu and Shimla district in Himachal Pradesh. Farmers were shown to be prone to numerous health conditions such as irritability, headache, weariness, vomits, and dizziness as a result of imprudent pesticide use.

Devarinti (2016) examined the fundamentals of natural farming, as well as its environmental benefits and long-term viability. He saw that traditional farming systems were experiencing challenges such as rising expenses and lower output. The topsoil was eroding as a result of mono-cropping. According to studies, soil fertility can be improved by using *Jeevamrit*. Natural farming has also been said to promote multi-cropping and biodiversity.

Bishnoi et al. (2017) reported that traditional agricultural approaches degrade soil and have poor health consequences. As a result of these tactics, the soil became barren and farmers got indebted. It was also revealed that the only way to deal with this was to

practice zero-budget natural farming. Crop rotation, compost and manure were indicated as the main ways of zero budget natural farming, and the four pillars of zero budget natural farming were identified as *Jeevamrit, Beejamrit, Acchadana,* and *Whapasa.*

Khadse et al. (2017) conducted a survey on reasons for embracing zero budget natural farming and revealed that farmers adopted zero budget natural farming in large numbers for a variety of reasons, including health concerns (52.00%), lower production costs (38.00%) and debt relief (30.00%).

Anonymous (2018) found that using the zero-budget technique increased cotton yields by 11 per cent, paddy yield by 12 per cent, groundnut yield by 23 per cent, and chilli yield by 34 per cent for less than half the cost of cultivation. Over 1,63,000 farmers on 1,50,000 acres of farmland distributed over six agro-climatic zones in Andhra Pradesh had successfully proved that growing without chemicals was a viable option.

Kumar et al. (2019) conducted a study using field surveys from farmers in Andhra Pradesh and Karnataka. Natural farming fields were found to be in superior shape in terms of soil health, moisture retention and other factors. It was also discovered that the cost of cultivation had decreased significantly. Farmers in Andhra Pradesh who used zero budget natural farming (ZBNF) used less fertilizer than those who didn't and their annual savings were likewise more considerable.

Koner and Laha (2020) analyzed the performance of zero budget natural farming (ZBNF) in the Perulia district of West Bengal based on cultivation expenses, income and yields. The study revealed that farmers who practiced zero budget natural farming (ZBNF) had lower production costs and higher income.

Smith et al. (2020) found that zero-budget natural farming might minimize soil deterioration and assist low-input farmers, the need for nitrogenous fertilizer was higher in higher-input systems. As a result, zero budget natural farming (ZBNF) may not help meet the N requirements of such systems.

2.4 Comparative analysis between conventional and natural farming

Khimajibhai (2007) conducted a study in Gujarat state to examine the economics of natural farming, marketing elements and identify the barriers to the selling of natural farming commodities and reported the yield per hectare in all three crops viz., wheat, groundnut and cotton was somewhat lower than that of conventional farming in the agricultural year 2005-2006; however, the price of natural farm produce was determined to be higher than that of conventional farming.

Anonymous (2018a) said that compared to chemical farming, the yields of different cash and food crops under zero budget natural farming (ZBNF) were shown to be much more significant. Cotton yields from zero budget natural farming (ZBNF) plots in the *Kharif* 2017 pilot phase were found to be 11 per cent higher on average than non-ZBNF plots. The yield of Guli ragi (ZBNF) was 40 per cent greater than the yield of non-ZBNF. Because no fertilizers or pesticides were employed, input costs were close to zero. Higher yields and fewer inputs were the primary sources of profit in most locations under zero budget natural farming (ZBNF). Drought and flooding were not a problem for model zero budget natural farming (ZBNF) farms, which were significant problems due to climate change. Planting various crops and border crops on the same field provides a variety of benefits.

Shrine (2019) examined the energy use patterns in rice production under zero budget natural farming, organic farming, and conventional farming in Andhra Pradesh' Visakhapatnam. It was discovered that conventional farming consumed the most energy per hectare, 23,055.60 MJ per ha. Human energy used in zero-budget natural farming, at 81.87 per cent, was likewise found to be the highest. Organic farming was deemed the most significant approach for rice production.

Shyam et al. (2019) researched the influence of zero-budget natural farming on farmer income and production costs. It was found that zero budget natural farming increased the soil health of practicing farmers' fields partially when compared to non-

practicing farmers' fields, with soil organic carbon and nitrogen levels 52 and 70 per cent higher in zero budget natural farming (ZBNF) fields than non-ZBNF fields, respectively. Before adoption, the average yield was 5,335 kg per ha, while after adoption, the average yield was 4,746 kg per ha.

Bharucha et al. (2020) used the data obtained by *RythuSadhikaraSamstha* from a crop cutting experiment done by farmers in Andhra Pradesh during 2016-17 to compare natural and conventional farming approaches. The results revealed that farmers had higher yields and lower expenses under zero budget natural farming (ZBNF) circumstances.

3. MATERIALS AND METHODS

Any scientific inquiry requires adoption of sound and methodology for investigating a phenomenon. The selection and application of appropriate methods bear more relevance in socio-economic studies based on sample surveys. The representative sample selection at the first instance and after that derivation of the plausible estimates invariably depends upon the methodology adopted. The present chapter deals with the research methodology adopted in selecting blocks, villages, and farmers for the current investigation. This chapter tells in detail about the methodological procedure followed to accomplish the stated objectives of the study along with the selection of study area, sampling design, and analytical framework employed in the study.

Keeping this in view, the chapter has been discussed under following headings:

3.1 Selection of the study area

The present study was conducted in the Bilaspur district of Himachal Pradesh. The elephant foot yam is commonly grown by the farmers in district Bilaspur. Thus, the study was purposely carried out in Bilaspur district of Himachal Pradesh as the cultivation of elephant foot yam is primarily concentrated in the district. Figure 3.1 and 3.2 shows the location of study area on the map of Himachal Pradesh.

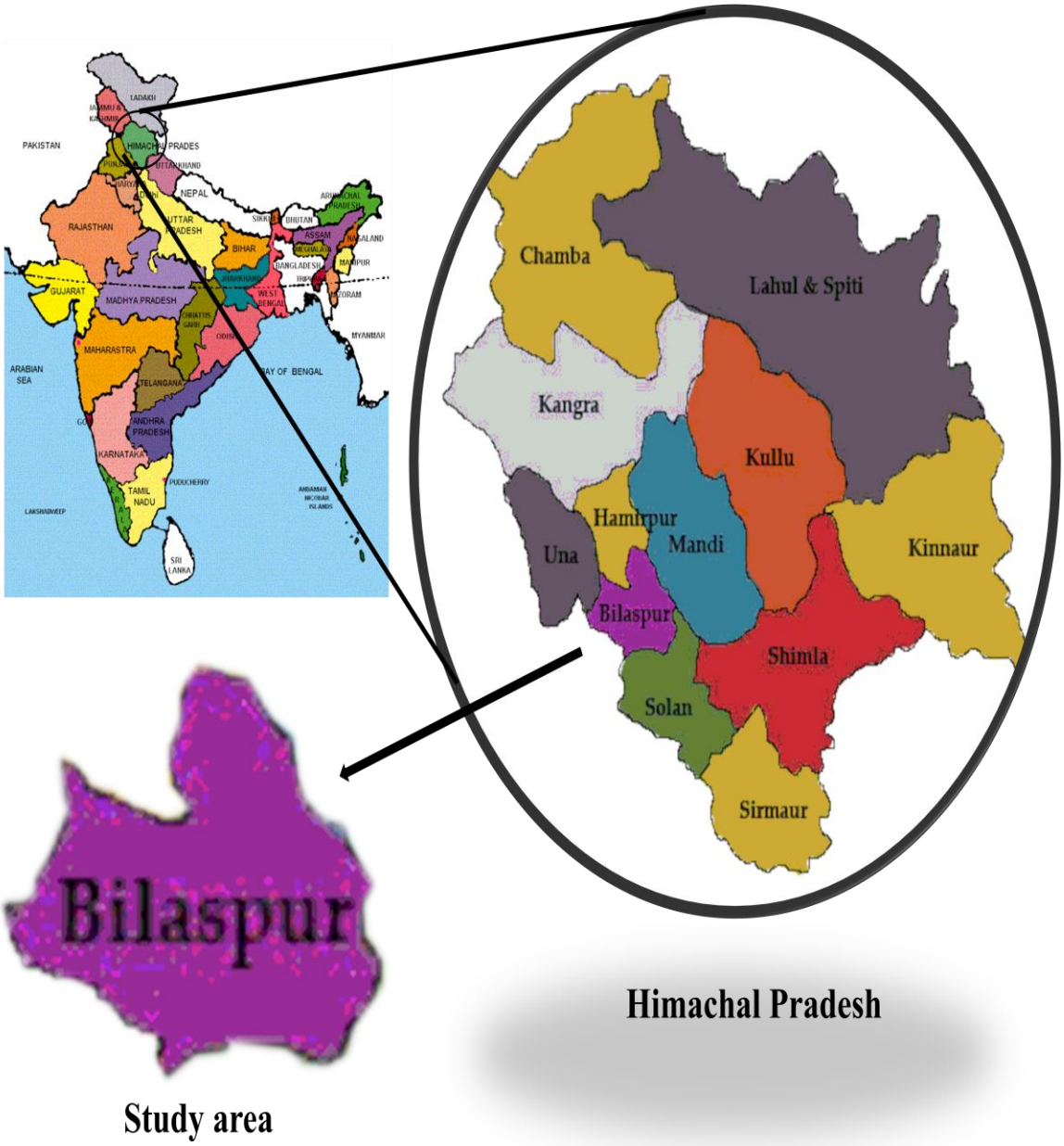

Fig 3.1 Map representing the location of Himachal Pradesh in India and District Bilaspur in Himachal Pradesh

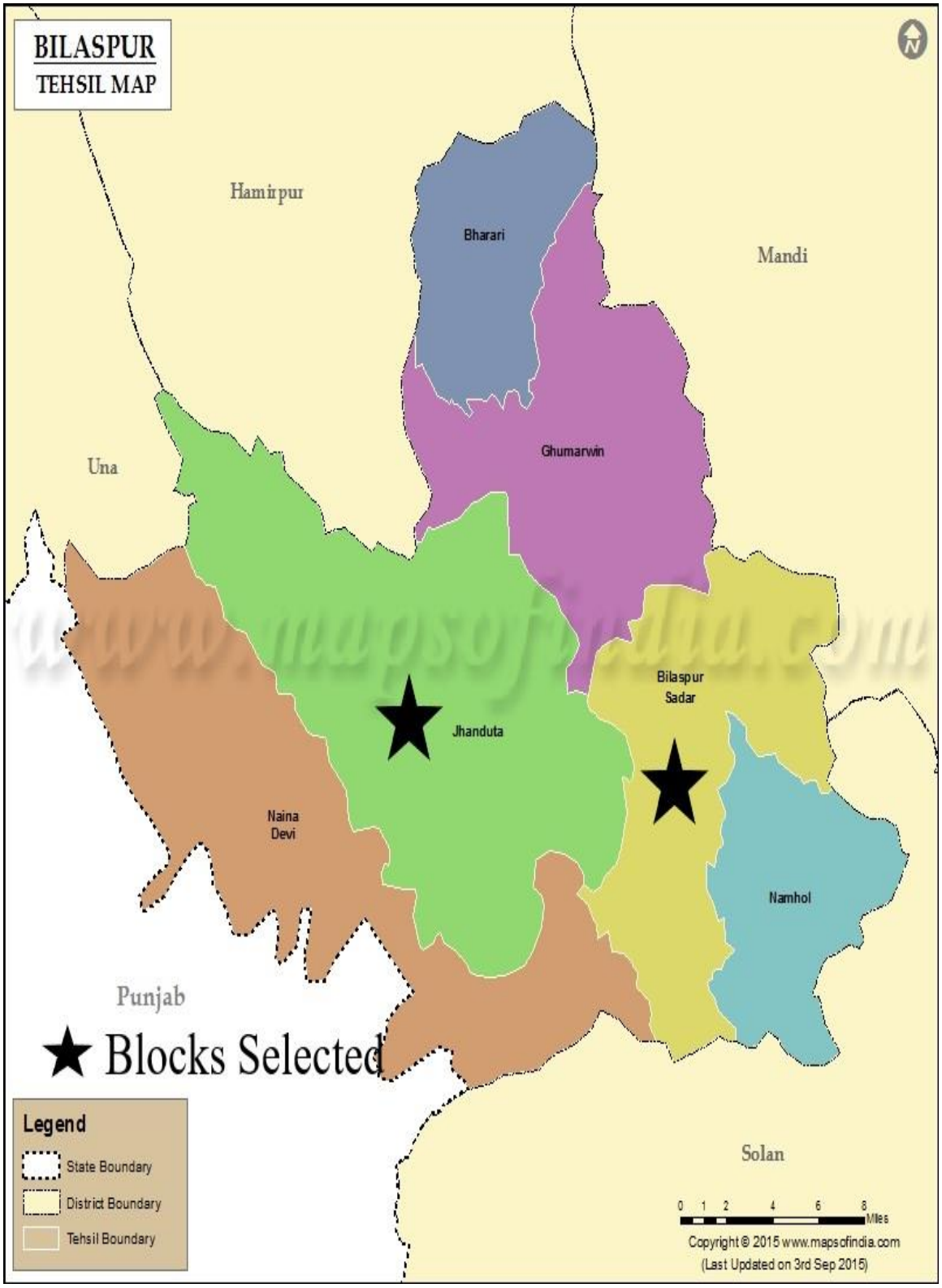

Fig 3.2 Map showing the location of study area

3.2 Sampling Design

Two stage random sampling technique was used in the study for the selection of the sample farmers to collect primary data. Out of the four development blocks, two blocks namely, Bilaspur Sadar and Jhanduta were selected purposely in consultation with the officials of the State Agricultural Department as these blocks had the maximum area under elephant yam crop.

3.2.1 Selection of the villages (Stage I)

In the first stage of sampling, a list of elephant foot yam growing villages for selected blocks was prepared in consultation with the officer of the Agricultural Department. From the list so prepared, a total sample of eight villages namely Karot, Makri Markand, Sayar Dobha, and Kuddi from Bilaspur Sadar and Faggog, Samleta, Thuran, Gherwin villages from Jhanduta block were selected randomly (Fig. 3.2 and Fig. 3.3).

3.2.2 Selection of the elephant foot yam growers (Stage II)

In the second stage, separate lists were prepared for the farmers growing elephant foot yam under conventional practices and for those growing under Subhas Palekar Natural Farming (SPNF) in the selected villages. A sample of 61 farmers in consultation with officer of agricultural department comprising 31 under conventional farming practices and 30 under SPNF practices were selected randomly from the list through proportional allocation method.

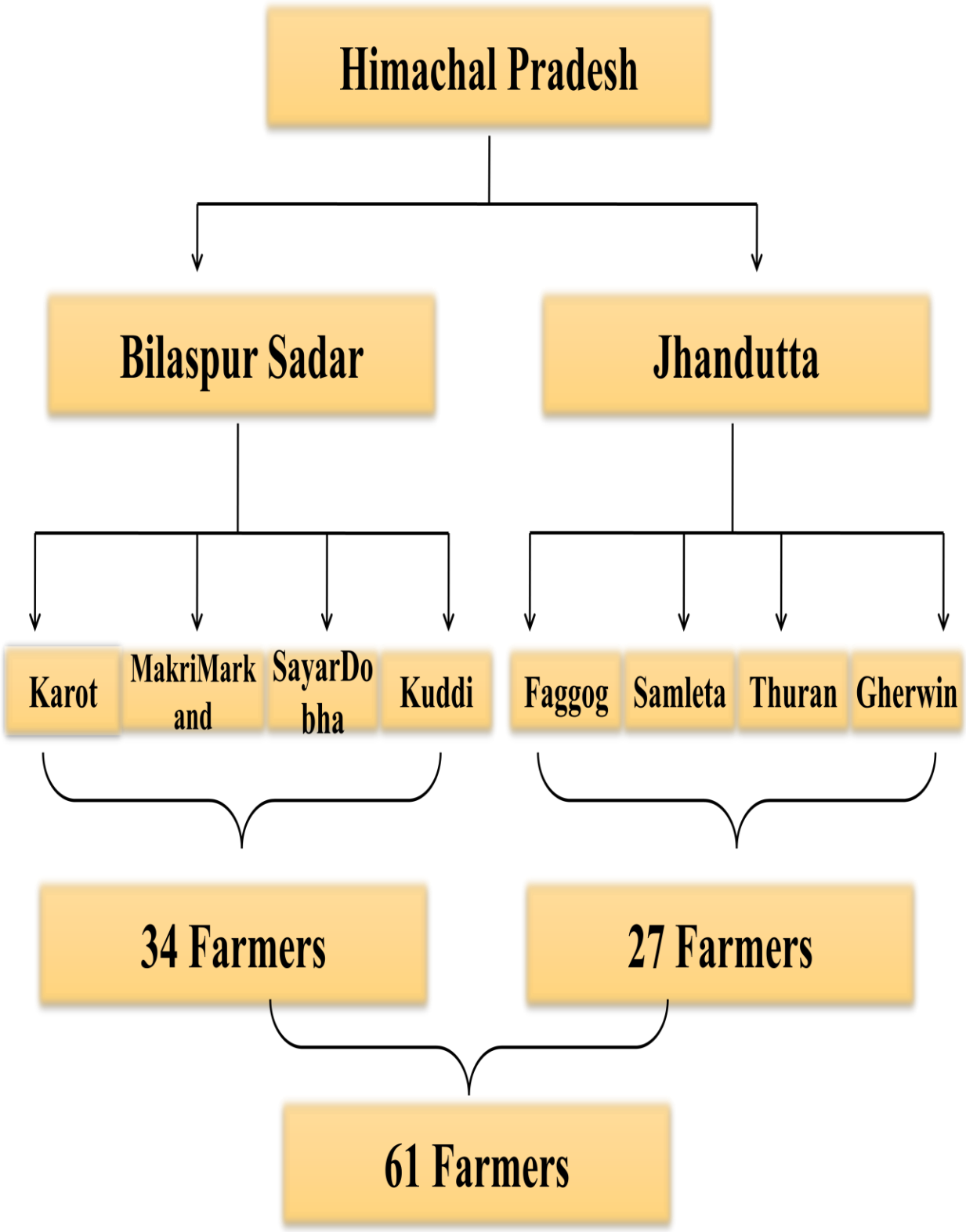

Fig. 3.3 Sampling design of the study

Table 3.1 Block and village wise description of sample farmers

Sr. No.	Block	Village	No of conventional farmers	No. of SPNF farmers
1	Sadar	Karot	5	4
		Makri Markand	5	3
		Sayar Dobha	4	5
		Kuddi	3	5
Sub total			17	17
2	Jhanduta	Faggog	4	4
		Samleta	6	5
		Thuran	2	2
		Gherwin	2	2
Sub total			14	13
Total			31	30

3.3 Collection of data

Both primary and secondary data were collected to meet requirement of objectives of the study.

3.3.1 Primary data

The data were collected through a personal survey method on a well-designed and pre-tested schedule from sample households. The detailed information on following aspects was obtained from the respondents in the agricultural year 2020-21:

1. Demographic parameters like age, family size, family structure, education, occupation, etc.
2. Farm inventories- inventory of building, land and it’s utilization, farm implements, tools, livestock, etc.

3. Farm resource utilization: cropping pattern, input use, production of crops, livestock, and other enterprises.
4. Costs incurred and returns from elephant foot yam.
5. Source of different inputs used by farmers of the study area.
6. Marketing aspects like marketed surplus, marketing system and the price at which produce was sold through different marketing channels, marketing cost and margins.
7. Problems faced by farmers in marketing of elephant foot yam.

3.3.2 Secondary Data

The secondary data pertaining to area, production and productivity of elephant foot yam in India and world were collected from various published and un-published secondary sources reports of the department of agriculture, government of India, websites, etc.

3.4 Analytical framework

To achieve the objectives of the study, both tabular and mathematical techniques were employed to analyze and interpret the data.

3.4.1 Tabular analysis

The primary data so collected was compiled in excel worksheet for further analysis. The measures like averages, ratios, percentages and indices were estimated to discuss different parameters:

1. Sex-ratio = $\frac{Total\ population\ of females}{Total\ population\ of\ males} \times 1000$

2. Literacy rate (%) = $\frac{Total\ number\ of\ literate\ persons}{Total\ population\ excluding\ non-school\ going\ below\ 5\ years\ age} \times 100$

Plate 1: Data Collection from farmers

3. Cropping intensity (%) = $\frac{Total\ cropped\ area}{Net\ cultivated\ area} \times 100$

4. Dependency ratio w.r.t total workers = $\frac{No.\ of\ dependents\ in\ t\ family}{No.\ of\ active\ workers}$

5. Average size of family= $\frac{Sum\ of\ all\ members\ of\ family\ in\ sample\ households}{Total\ no.\ of\ sample\ households}$

3.4.2 Economics of natural and conventional farming

The aspects are different from each other in following aspects:

1. Comparative analysis of input use

The cost of different inputs utilized in natural farming and conventional farming were compared using the tabular analysis.

2. Comparative economics of natural and conventional farming

The returns over different costs were compared for elephant foot yam. The comparison was made on the basis of cost cultivation, Yield, gross returns, and input-output ratio over additional costs.

4. Companion crops

In SPNF, companion crops like soyabean, black gram, green gram, pea, chickpea, etc. were used to be grown by the respondents along with elephant foot yam, while under conventional farming, these were missing. These leguminous crops helps in supplementation of Nitrogen from atmosphere to main crop, help in checking the weed growth and provide additional returns. The Yield of different intercrops or crops sequences is converted into equivalent Yield of any one crop based on the price of the produce. It is estimated by:

$$\text{Crop Equivalent Yield (CEY)} = C_{\gamma} + C_{\gamma 1}\frac{P1}{P0} + C_{\gamma 2}\frac{P2}{P0}$$

where,

C_{γ}=Yield of main crop

$C_{\gamma 1}$ =Yield of first crop to be converted in main crop

$C_{\gamma 2}$ = Yield of second crop to be converted in main crop

P_0 =Price of main crop

P_1 = Price of first crop to be converted in main crop

P_2 = Price of first crop to be converted in main crop

3.4.3 Cost of cultivation

According to CACP's definition, costs were calculated using specific cost ideas. The cost of cultivation of elephant foot yam under SPNF and CF were estimated as per the guidelines of CACP (Singh and Bhogal, 2021).

CostA_1:

a) Seed/Corms cost
b) Value of manures, fertilizers, and plant protection
c) Charges for SPNF input preparation
d) Hired human labour
e) Bullock labuor
f) Owned and hired machinery
g) Depreciation on implements, farm buildings, and irrigation structures
h) Interest on working capital
i) Land revenue

Cost A_2: Cost A_1 + rent paid for leased in land

Cost B_1: Cost A_1 + imputed interest on the fixed capital assets excluding land

Cost B_2: Cost B_1 + imputed rental value of owned land + rent paid for leased in land.

Cost C: Cost B_1 + imputed value of family labour

Cost D: Cost C_1 + 10 per cent of cost C_2 on account of managerial function performed by the farmer.

In addition to these, following costs were also estimated

1. **Total variable cost:** Sum of all variable costs incurred in production + depreciation on fixed capital assets.
2. **Total Fixed cost:** Interest on fixed capital assets + imputed value of family labour + imputed rental value of owned land
3. **Total cost:** Total variable cost + Total fixed cost

3.4.4 Cost of production

The cost of elephant foot yam production was estimated by using the following formula:

$$CP = \frac{TC}{TP}$$

CP is the cost of Elephant Foot Yam production (₹/q)

TC is the total cost of Elephant Foot Yam production (₹/ha)

TP is the quantity of Elephant Foot Yam produced (q/ha)

3.4.5 Computation of gross returns

The gross returns of elephant foot yam crop were estimated by using the following relationship:

$$\text{Gross returns} = Yg \times Pg$$

where,

Yg = Yield of elephant foot yam (q/ha)s

Pg = Price of elephant foot yam (₹/q)

3.4.6 Computation of net returns

The net returns over different costs for elephant foot yam were calculated by using the following formula:

Net returns = Gross returns – Total cost

Returns over variable costs were also calculated by subtracting variable costs from gross returns.

3.4.7 Marketing of Elephant Foot Yam, the following marketing aspects were studied

1. Marketable surplus:

$$MS = TP – (HC+ KP+ G)$$

where,

MS = Marketable surplus of Elephant Foot yam (q)

TP = Total production (q)

HC = Home consumption (q)

KP = Kind payment (q)

G = Gift (q)

2. Marketed surplus:

$$M_t = MS - L_M$$

where,

M_t= Marketed surplus i.e. actual quantity of elephant foot yam sold in the market (q)

L_M = Losses during transportation (q)

3. Marketing Channels

Marketing channels were defined as the chain of intermediaries through which the various commodities pass from producers to consumers. Various marketing channels patronized by the growers for the marketing of Elephant Foot yam in the study area were examined by a personal survey of different intermediaries involved in the marketing process. Following marketing channels were as under:

Channel-I : Producer - Consumer

Channel-II : Producer –Retailer- Consumer

Channel-III : Producer –Trader- Consumer

Channel-IV : Producer –Wholesaler-Retailer- Consumer

4. Marketing cost and margins

Marketing cost:

$$T_c = C_p + \sum M_{ci}$$

where;

T_c = Total marketing cost

C_p = Marketing cost borne by producer

M_{ci} = Marketing cost incurred by i^{th} trader

5. Marketing cost:

At the farmers' level: This includes the cost incurred on different operations performed by the farmers after harvesting/picking the crop.

At market level: This includes costs incurred by different intermediaries on different marketing operations like packaging, loading, transportation, commission paid to other intermediaries, and additional costs including auction, market fee, etc.

6. Producer's share in consumer rupee: The price received by the farmer is expressed as a percentage of the retail price. It has been calculated by using the following formula;

$$G_s = (P_g / P_{cr}) \times 100$$

where,

G_s = Growers' share in consumer's rupee

P_g = Growers' price for his produce

P_{cr} = Price paid by consumer or sale price of retailer

7. Total cost of marketing: The total cost incurred on different functions of marketing either in cash or in-kind by the product/seller and by various traders involved in the sale and purchase of the crop till it reaches the ultimate consumer was computed by using the formula:

$$TC = Cg + \sum M_{ci}$$

where,

TC = Total cost of marketing

Cg =Costs incurred by the grower in marketing

Mc = Marketing costs incurred by the i^{th} middleman

3.4.9 Problems or constraints faced by growers and traders

Garrett's ranking technique was employed to know the constraints in elephant foot yam cultivation. It changes the order of constraints and advantages into numerical scores. The significant advantage of this technique compared to simple frequency distribution was that the constraints were arranged based on their importance from respondents.

Hence, the same number of respondents on two or more conditions may have been given different ranks. Garrett's formula for converting ranks into per cent is given by:

$$\text{Per cent position} = \frac{100 \times (Rij - 0.5)}{Nj}$$

where,

R_{ij}= Rank given for i^{th} factor by j^{th} individual

N_j = Number of factors ranked by j^{th}individual

The per cent position of each rank was converted into scores referring to the table given by Garrett's and Wood's worth (1969). The scores of individual respondents were added together and divided by the total number of respondents for whom scores were added. These mean scores for all the factors were arranged in descending order. Ranks were given, and the most important factors were identified (Gareett and Woodworth, 1969).

3.5 Limitation of the study

The present study was subjected to the following limitation:

1. Keeping the time and cost factors into consideration, the investigation was restricted only to 61 elephant foot yam growers (consisting of 31 growers of conventional practices and 30 of SPNF) from two blocks Jhanduta and Sadar of Bilaspur. However, an attempt was made to obtain an accurate representative sample of elephant foot yam growers in the study area.

2. Elephant foot yam growers did not maintain proper farm records and accounts. The data for present investigation were collected through personal interview methods, and the information so collected was based on the memory and experience of the respondents.

3. Efforts have been made to extract the exact information by cross-checking and pre-testing the survey schedule in the study area. Still, the possibility of a few slips from the respondents' memory could not be ruled out.

4. The study is confined to the agricultural year 2020-21. Hence, it needs to be simulated for future situations because of the change in technology and prices of inputs and output.

4. RESULTS AND DISCUSSION

This chapter represents a systematic presentation of results obtained from the analysis of data and is of utmost importance in any investigation. The status of vegetables and elephant foot yam cultivation in India, Himachal Pradesh and Bilaspur district, Subhash Palekar Natural Farming(SPNF) practices and its status in state and study area, brief description of the study area, demographic features of respondents, farm inventories, cropping pattern, input use pattern in the cultivation of elephant foot yam, utilization pattern, marketing costs, the channel of marketing adopted, and problems faced in production, and marketing of elephant foot yam have been discussed under following sections:

4.1 Status of vegetables and elephant foot yam cultivation

4.2 Subhash Palekar Natural Farming (SPNF) in Himachal Pradesh

4.3 Description of the study area

4.4 Socio-economic and structural characteristics of sample elephant foot yam growers

4.5 Source-wise annual gross household income

4.6 Farm inventory and investment

4.7 Land utilization pattern

4.8 Cropping pattern and productivity

4.9 Costs and Returns

4.10 Production and disposal of major crop produce on sample farm under different farm practices

4.11 Marketing channels for elephant foot yam in the study area

4.12 Problems and constraints in elephant foot yam cultivation

4.13 Problems and constraints in marketing of elephant foot yam cultivation

4.1 Status of vegetable and elephant foot yam cultivation

India has emerged as the world's second-largest producer of fruits and vegetables and has attained the position of largest producer of vegetables like ginger, okra, potato, onion, cauliflower, brinjal and cabbage (Anonymous, 2021). Scenario of vegetable and elephant foot yam cultivation at national and state level has been discussed in following paragraphs.

4.1.1 Vegetables and elephant foot yam cultivation in India

In order to improve the socio-economic status of farming community, the cropping systems are being diversified through the introduction of vegetable crops. The proportion of high-value crops in the value of agricultural production is increasing, both in absolute and per cent terms. The horticultural industry contributes to around 37 per cent of overall agricultural commodity exports, and exports have been steadily increasing (Jha et al., 2018). Total production of vegetables in India in 2019-20 was 189.464 lakh MT with 103.16 lakh ha under cultivation (Table 4.1).

Table 4.1: Area, production and yield of elephant foot yam in India

(Area in '000 ha Production in '000 MT)

Year	All vegetables		Elephant foot yam	
	Area	Production	Area	Production
2013-14	9396	162897	5 (0.05)	222 (0.14)
2014-15	9542	169478	24 (0.25)	678 (0.40)
2015-16	10106	169064	28 (0.27)	733 (0.43)
2016-17	10238	178172	29 (0.28)	748 (0.42)
2017-18	10259	184394	30 (0.29)	774 (0.42)
2018-19	10073	183170	33 (0.33)	817 (0.45)
2019-20	10316	189464	33 (0.32)	801 (0.42)

Note: Figures in parentheses indicate percentages to the national area and production of all vegetables.

Source: Horticulture Statistics at a Glance-2020

As far as elephant foot yam was cultivated on 33,000 ha area in India and with a production of 801,000 metric tonnes (Anonymous, 2020a). Although its contribution in total vegetable cultivation was just 0.42 per cent but area and production of this crop has increased manifolds during period 2013-20, which highlights the increasing importance and popularity of this crop. It is mainly cultivated during the *Zaid* and *Kharif* seasons, and takes around eight to nine months to complete its life cycle. It is mainly produced in Andhra Pradesh, West Bengal, Karnataka, Kerala, Tamil Nadu, Madhya Pradesh, Chhattisgarh, and Bihar (Anonymous, 2021a), as well as in northern and eastern regions (Table4.2). Its indigenous cultivars are mostly used for preparation of pickles and medicinal uses. In India, this crop is also cultivated as an intercrop with crops like banana, coconut etc. The introduction of Gajendra, a non-irritant smooth corm type variant, proved boon for elephant foot yam farming in India, resulting into magnificent increase in its acreage and production.

Table 4.2: Area, production and yield of elephant foot yam in major states of India

(A= Area in '000 ha P= Production in '000 MT)

State	All Vegetables Crop						Elephant foot yam					
	2013-14		2014-15		2015-16		2013-14		2014-15		2015-16	
	A	P	A	P	A	P	A	P	A	P	A	P
Andhra Pradesh	439.64	8149.76	242.18	4592.58	238.39	5442.77	2.97 (0.68)	146.80 (1.80)	3.30 (1.36)	181.63 (3.95)	3.61 (1.51)	207.52 (3.81)
Bihar	809.79	15097.76	841.99	14467.14	837.51	14400.12	0.70 (0.09)	32.22 (0.21)	0.77 (0.09)	36.16 (0.25)	0.50 (0.06)	36.20 (0.25)
Tamil Nadu	289.74	8678.82	284.80	7521.02	271.27	6976.14	1.24 (0.43)	43.38 (0.50)	0.94 (0.33)	34.59 (0.46)	1.05 (0.39)	38.76 (0.56)
Karnataka	-	-	485.87	8828.36	460.34	7804.56	-	-	0.42 (0.09)	9.40 (0.11)	0.37 (0.08)	14.53 (0.19)
Kerala	-	-	142.29	1645.06	144.99	2088.66	-	-	4.85 (3.41)	126.09 (7.66)	4.86 (3.35)	110.37 (5.28)
Puducherry	-	-	1.40	43.73	-	-	-	-	0.06 (4.29)	1.58 (3.61)	-	-
Tripura	-	-	48.61	811.09	46.48	793.24	-	-	0.06 (0.12)	1.41 (0.17)	0.09 (0.19)	2.18 (0.27)
Chhattisgarh	-	-	-	-	475.22	6318.40	-	-	-	-	3.07 (0.65)	25.99 (0.41)
Madhya Pradesh	-	-	-	-	757.67	15568.25	-	-	-	-	0.19 (0.03)	3.33 (0.02)
West Bengal	-	-	-	-	1391.41	22825.44	-	-	-	-	14.03 (1.01)	293.84 (1.29)
India	9396.06	162896.91	9452.23	169478.23	10106.29	169063.93	4.90 (0.05)	222.39 (0.13)	24.23 (0.25)	677.68 (0.39)	27.78 (0.27)	732.73 (0.43)

Note: Figures in parentheses indicate percentages to the national area and production of all vegetables.

Source: National Horticulture Board, 2020

4.1.2 Status of vegetable cultivation in Himachal Pradesh

The state has witnessed enormous metamorphosis of the agriculture scenario during the last five decades after attaining statehood in the year 1971. Previously, agricultural economy of the state was centered around low value traditional crops like cereals, pulses, millets etc. The comparative advantage of the state in fruits and vegetable production particularly off-season vegetables and temperate fruits due to favourable and varied agro-climatic conditions, is being harnessed by the farmers. This produce commands a high price in marketplaces, encouraging farmers to pursue cash crop farming as a career, thereby, and raising peasant's living conditions. The consumers in neighbouring states have a unique fondness for hill-grown vegetables because of their distinct flavour, freshness, sweetness, and crispness.

Table 4.3 shows the trends in area, production, and productivity of vegetable cultivation in Himachal Pradesh. The state's vegetable crops area rose to 1, 01,240 ha in 2019-20 from 91,200 ha in 2013-14 registering an increase of about 11per cent. Similarly vegetable production increased to 20.57 lakh tonnes in 2019-20 registering an increase of 23.12 per cent over 2013-14. Vegetable crop productivity in the state grew to 20.32 tonnes per ha in 2019-20 from 18.32 tonnes per ha in 2013-14.

Table 4.3: Area, Production and productivity of vegetable crops in Himachal Pradesh, 2013-14 to 2019-20

(Area in '000 ha Production inLakh tonnes)

Year	Area	Production	Yield
2013-14	91.20	1671.00	18.32
2014-15	88.57	1757.83	19.84
2015-16	93.25	1791.80	19.21
2016-17	98.02	1855.94	18.93
2017-18	94.55	1890.22	19.99
2018-19	90.95	1746.99	19.21
2019-20	101.24	2057.38	20.32

Source: Statistical Abstract of Himachal Pradesh (2020-21), Economics and Statistic, Department, Govt. of H.P

4.1.3 Vegetable cultivation in district Bilaspur

Agriculture is the mainstay of the people in Bilaspur district, and they earn their livelihood from agriculture. The geographical area of the district was 1,11,776 ha, out of which the net sown area was 28,941 ha, and the total cropped area was 58,183 ha with a production of 2,18,751 MT. The irrigation facilities in the district were available to 3850 ha area, which accounts for about 13 per cent of net area sown. In 2019-20, the total production of vegetables from 3,554 ha in the district was 94,641 tonnes, out of which elephant foot yam was grown in 86 ha, having a production of 3,355 MT (Anonymous, 2020b).

Table 4.4: Area and production of major crops in Bilaspur district (2020-21)

Sr. No.	Particulars	Area (ha)	Production (MT)	Yield (t/ha)
A	Cereal Crops			
1	Wheat	27511 (46.99)	49000 (22.39)	1.78
2	Maize	25803 (44.07)	70500 (32.21)	2.73
3	Paddy	954 (1.63)	1070 (0.49)	1.12
B	Pulses	23 (0.04)	3540 (1.62)	153.91
C	Vegetables			
1	EFY	86 (0.15)	3698 (1.53)	43.00
2	Other vegetable crops	3468 (5.92)	91286 (41.71)	26.32
D	Oilseed crop	361 (0.62)	100 (0.05)	0.28
E	Fodder	338 (0.58)	-	-
Total cultivated area/production		58183 (100.00)	218751 (100.00)	-

Note: Figures in parentheses indicate percentages to the district total.
Source: Statistical Abstract of Bilaspur (2020-21), Economics and Statistic, Department, Govt. of H.P

The principal crop grown in the district was wheat having an area of 27,511 ha, accounting for 46.99 per cent of the total cropped area in the district with the production of 4900 MT, which is 22.39 per cent of total production of all crops (Table 4.4). Maize was another important crop grown in the district during the *Kharif* season. It has area 25,803 ha under its cultivation which accounts for 44 .07 per cent of the total cultivated area, with a production of 70,500 MT. Among oilseed crops like sesame, mustard etc. were also grown by the farmers of Bilapsur district having an area of 361 ha and production of 100 MT.

4.1.4 Area, production and yield of elephant foot yam cultivation in district Bilaspur

Table 4.5 illustrates the scenario of vegetable cultivation in the Bilaspur district of Himachal Pradesh. During 2016-17to 2019-20, the area under vegetable production in the district increased, from 3221 ha to 3554 ha, while elephant foot yam area increased from 33 ha to 86 ha marking an increase of 10.33 and 160.60 per cent, respectively. The production had increased from 161.51 per cent, from 1414.05 tonnes in 2016-17 to 3698 tonnes in 2019-20 registering an increase of about 162 percent during the period. Elephant foot yam accounted for 2.45 per cent of total vegetable acreage and 3.95 per cent output in the district of Bilaspur in 2019-20. Its productivity also increased marginally from 40.20 tonnes per ha in 2013-14 to 43 tonnes per ha in 2019-20.

Table 4.5: Area, production and yield of vegetables and elephant foot yam cultivation in Bilaspur district

Year	All vegetable			Elephant foot yam		
	Area (ha)	Production (t)	Yield (t/ha)	Area (ha)	Production (t)	Yield (t/ha)
2016-17	3221	86258	26.78	33 (1.02)	1414.05 (1.64)	42.85
2017-18	3240	87865	27.12	22 (0.67)	933.68 (1.06)	42.44
2018-19	3317	90350	27.24	150 (4.52)	6450.00 (7.14)	43.00
2019-20	3554	94641	26.63	86 (2.41)	3698.00 (3.91)	43.00

Note: Figures in parentheses indicate percentages to the state area and production of all vegetables and elephant foot yam.

Source: Statistical Abstract of Bilaspur (2020-21), Economics and Statistic, Department, Govt. of H.P and Department of Revenue, Distt. Bilapsur, H.P.

4.2 Subhash Palekar Natural Farming (SPNF) in Himachal Pradesh

The government of Himachal Pradesh launched a new scheme called "*Prakritik Kheti Khushhal Kisan Yojana*," in the year 2018 with an aim to increase the farmers' income. This scheme had adopted innovative chemical free natural farming technique called "Subhash Palekar Natural Farming" (SPNF) to achieve objectives of the scheme. Himachal Pradesh is the second state in India to do so after Andhra Pradesh. SPNF was adopted to reduce the cost of cultivation and increase farm income for the extended and long-term welfare and prosperity of farmers and to protect them from adverse impacts of climate change (Anonymous, 2021b).

4.2.1 Importance of Subhash Palekar Natural Farming (SPNF)

SPNF was pioneered by Mr. Subhash Palekar, a *Padma Shri* Awardee, who is regarded as the "Father of zero budget natural farming" all over the country. The farmers' in SPNF is not dependent upon the markets or externally sourced inputs for growing crops(Anonymous, 2021b).

4.2.2 Pillars of Natural Farming

Mr. Subhash Palekar has identified 04 wheels of SPNF which require locally available material

1. ***Beejamrit*** **(Culture of micro-organisms):** It is a treatment used for seeds, seedlings or any planting material. *Beejamrit* is effective in protecting young roots from fungus as well as from soil-borne and seed-borne diseases that affect plants after the monsoon period. It is consisting of local cow dung, cow urine, flour of gram, jaggery (gur), a pinch of soil and water.

2. ***Jeevamrit*** **and** ***Ghanjeevamrit*** **(Best culture of fertility creating microorganisms):** It is a fermented microbial culture. It not only provides nutrients, but most importantly, acts as a catalytic agent that promotes the activity of microorganisms in the soil, as well as increase earthworm activity; during the 48-hour fermentation process. It is composed of local cow dung, cow urine, flour of any pulses, jaggery (gur), a pinch of soil and water. The aerobic & anaerobic bacteria present in the cow dung & urine multiply as they eat up organic ingredients present in the *Jevamrit*.

3. **Mulching:** Covering of soil surface with live or crop residues. It is necessary to create the micro climate under which micro-organisms can develop well. Usually, 25-32^0 C temperature and 65-70 per cent moisture is required for a plant to develop well. Mulching promotes humus formation, suppresses weeds and maintains the water requirement of crops.

4. ***Waapsa* (Soil aeration mixed with water vapours):** *Waapsa* is the condition where there are both air molecules and water molecules present in the soil, and encourages reducing irrigation, irrigating only at noon, in alternate furrows SPNF farmers report a significant decline in need for irrigation in SPNF.

In this system, various aadans (decoctions) are made with indigenous cow's dung and urine, garlic plants and green chilly extracts:

- For management of insect-pests and diseases
- For crop protection by biological control system with friendly insects

Other important principles of SPNF

Intercropping – This is primarily how SPNF gets its "Zero Budget" name. It doesn't mean that the farmer is going to have no costs at all, rather any costs will be compensated for by income from intercrops, making farming a close to zero budget activity. As per Palekar, the crop and tree associations works well for the South Asian context.

Contours and bunds – In order to preserve rain water, it is necessary to make the contours and bunds, which promote maximum efficacy for different crops.

Local species of earthworms–Contrary to the use of vermicompost, Palekar has claimed that the revival of local deep soil earthworms through increased organic matter is most recommended.

Cow dung – Indigenous cow *Bos indicus* (humped cow) is the base of the Subhash Palekar Natural Farming. Cow dung and urine-based formulations are used in this farming method instead of chemical fertilizers and pesticides. It has proven to be a miraculous cure to revive the fertility and nutrient value of soil. According to Palekar, dung from the *Bos indicus* (humped cow) is most beneficial and has the highest concentrations of micro-organisms as compared to

European cow breeds such as Jersey and Holstein. The entire SPNF method is centered on the Indian cow, which historically has been part of Indian rural life.

4.2.3 SPNF in Bilaspur

Various achievements under *Prakritik Kheti Khushhal Kissan* (PK3) Yojana in Bilaspur district and Himachal Pradesh up to August, 2021 are presented in Table 4.6. Total 8168 farmers in Bilaspur district were trained on SPNF practices out of which 6723(5.05%) of total farmers trained in Himachal Pradesh farmers had started practicing the SPNF on their fields. Farmers doing SPNF practices in Bilapsur district was 82.30 per cent of total farmers trained in district. Crops through SPNF practices were being grown on a total 357 ha in the district. Assistance had been provided to 149 farmers for lining of their cow shed for collection of cow dung and urine, which are the major components used in preparation of SPNF inputs. Subsidy up to ₹ 25000 has been provided to the framers for purchase of 53 indigenous cows. Assistance had been provided for establishing 60 resource centers (*Sansadhan bhandars*) in Bilapsur district so that SPNF inputs can be provided at nominal rate to those farmers who don't own indigenous cows.

Table 4.6: Achievements of *'Prakritik Kheti Khushhal Kissan'* Yojna, (upto 31 Aug, 2021)

Sr. No.	Components	Unit	Himachal Pradesh	Bilaspur
1	Trainings	No.	4454	201 (4.51)
2	Total No. of farmers Trained	No.	146640	8168 (5.57)
3	No. of Panchayat covered under SPNF	No.	3551	176 (4.95)
4	No. of farmers practicing SPNF	No.	133056	6723 (5.05)
5	Area covered under SPNF	Ha.	7609	357 (4.69)
6	Indigenous Cow	No.	961	53 (5.51)
7	On farm input Generation (plastic drums/tanks)	No.	41829	1915 (4.57)
8	Lining of cowshed	No.	3206	149 (4.64)
9	Resource centers (Sansadhan Bhandars)	No.	1009	60 (5.94)

Source: SPIU, Department of Agriculture, Shimla
Note: Figures in parentheses indicate percentages to the total in each category.

Table 4.7 shows the distribution of farmers, area and trainings among the different blocks of Bilaspur district. Participation of male and female farmers in the SPNF activities at the district level was almost equal; however, in Ghumarwin and Jandutta blocks, women participation was 31.54 and 27.27 per cent, respectively, was higher than their male counterparts which were 23.63 and 24.71 per cent, respectively. Maximum area under SPNF crops was in Ghumarwin block (29.29%) followed by Bilaspur Sadar (25.09%), Jhanduta (21.13%) and Shri Naina Devi (24.48%) blocks. Maximum sensitization trainings of the farmers on SPNF practices were conducted in Bilaspur Sadar (28.96%) followed by Jhanduta (26.23%), Ghumarwin (22.95%) and Shri Naina Devi (21.86%) blocks.

Table4.7: Block-wise data of farmers who adopted SPNF during year 2019-20

Sr. No.	Name of Block	Farmers			Area (ha)	Number of Trainings
		Male	Female	Total		
1	Ghumarwin	783 (23.63)	1012 (31.54)	1795 (27.52)	76.7 (29.29)	42 (22.95)
2	Jhandutta	819 (24.71)	875 (27.27)	1694 (25.97)	55.35 (21.13)	48 (26.23)
3	Bilaspur Sadar	944 (28.49)	718 (22.37)	1662 (25.48)	65.72 (25.09)	53 (28.96)
4	Shri Naina Devi	768 (23.17)	604 (18.82)	1372 (21.03)	64.12 (24.48)	40 (21.86)
Total		3314 (100.00)	3209 (100.00)	6523 (100.00)	261.89 (100.00)	183 (100.00)

Source: SPIU, Department of Agriculture, Shimla
Note: Figures in parentheses indicate percentages to the total in each category.

4.3 Description of the study area

Bilaspur is one of the 12 districts of Himachal Pradesh. The district is located between 31° 12' 30" and 31° 35' 45" North latitude and 76° 23' 45" and 76° 55' 40" east longitude in the outer Himalayan hills close to the Punjab plains. It is part of the Sutlej River Basin, which runs

for 90 kilometers through it. It is bordered on the north by the districts of Mandi and Hamirpur, on the west by Hamirpur and Una, and on the south by the district of Solan.

Table 4.8 summarizes the key characteristics of the district of Bilaspur. The district's geographical area is 1167 square kilometers. This district covers 2.1per cent of the state's total geographical area but accounts for 5.56 per cent share in state's total population which highlights the comparatively higher population density. The rural areas are home to the majority of the people. In comparison to the state (972), the district had a relatively better sex ratio (981). The literacy rate (84.59 .3%) was also better than the state's average (82.80 %). Cropping intensity in the district was 175.18 per cent against 186.17 per cent at state level, thereby, indicating the higher crop intensification level in the district.

Table 4.8: Salient features of district Bilaspur and Himachal Pradesh (2020-2021)

Sr.No.	Particulars	Himachal Pradesh	Bilaspur	Percentage
1	Area (sq. km.)	55,673	1,167	2.10
2	Tehsil (No.)	106	4	3.77
3	Sub-Tehsils (No.)	63	3	4.76
4	Development Blocks (No.)	80	4	5.00
5	Population (No.)	68,64,602	3,81,956	5.56
6	Rural population (No.)	61,76,050	3,56,827	5.78
7	Urban population (No.)	6,88,552	25,129	3.65
8	Total cropped area ('000 ha) in	959223	55507	5.79
9	Net sown area ('000 ha)	547556	29815	5.45
10	Cropping intensity (%)	175.18	186.17	-
11	Sex-ratio (females per 1000 males)	972	981	-
12	Literacy rate (%)	82.8	84.59	-
13	Male	89.53	91.16	-
A	Female	75.93	77.97	-
B	Rainfall	1232.2	1371.3	-

Source: Statistical Abstract of Himachal Pradesh (2020-21), Economics and Statistic, Department, Govt. of H.P

4.4 Socio-economic and structural characteristics of sample elephant foot yam growers

Farmers' socio-economic traits have a significant impact on farm organization, management, production and disposal of various agricultural commodities. So, it's critical to look at the sample elephant foot yam grower's current socio-economic situation. Land ownership, cropping patterns, family size, and educational levels all significantly impact decision-making in the adoption of innovations and improved practices. Therefore, this part aims to shed light on the socio-economic characteristics of the sample farms.

4.4.1 Family structure and size

Family size plays a vital role in the decision-making process in running the farm business to a great extent as most of the farm activities are performed by the family members only. It is also an important indicator to determine the social and economic setup of the families living in the area under consideration. The family size and structure of the sample households are given in Table 4.9. The average family size (4.65) was slightly higher in conventional farming (CF) practicing households as compared to SPNF (4.07). The proportion of nuclear families was higher (56.00%) in SPNF than the CF (45.00%) and the joint family system was more prevalent in the CF households (55.00%). Sex ratio in SPNF (53.49 %) was higher than CF families (49.31%).

Table4.9: Structure and average family size of sample households on sample farms under different farming practices

(Numbers)

Sr. No.	Particulars	CF	SPNF
1	Average family size (No.)	4.65	4.07
2	Family composition (%)		
i.	Male	82 (51.57)	69 (51.49)
ii.	Female	77 (48.42)	65 (48.50)
	Total	159 (100.00)	134 (100.00)
	Sex Ratio	939	942
3	Family structure		
i.	Joint	17 (55.00)	13 (44)
ii.	Nuclear	14 (45)	17 (56)
4	Total households	31 (100.00)	30 (100.00)

Note: Figures in parentheses indicate percentages to the total in each category.
CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

4.4.2 Age-wise distribution

It is generally believed that the age factor helps in the decision-making process as decision-making skills develop with experience over time.

4.4.2.1 Heads of Families

The age of the head is an essential factor to consider as it plays an indispensable role in responding to scientific innovations and newer initiatives. Table 4.10 indicates that the majority of the elephant foot yam growers in CF (70.97 %) and SPNF (90.00%) belong to 41-60 years age group (Fig.4.1). Majority of heads of the family were in the age group of 26 to 60 years and had major involvement in performing, supervising the various farm and marketing operations.

Table 4.10: Age-wise distributions of heads of the families of sample farms under different farming practices

(Numbers)

Sr. no.	Age Group(years)	CF	SPNF
1	<26	-	-
2	26-40	7 (22.58)	3 (10.00)
3	41-60	22 (70.97)	27 (90.00)
4	>60	2 (6.45)	-
Total		31 (100.00)	30 (100.00)

Note: Figures in parentheses indicate percentages to the total number of heads in each category.
CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

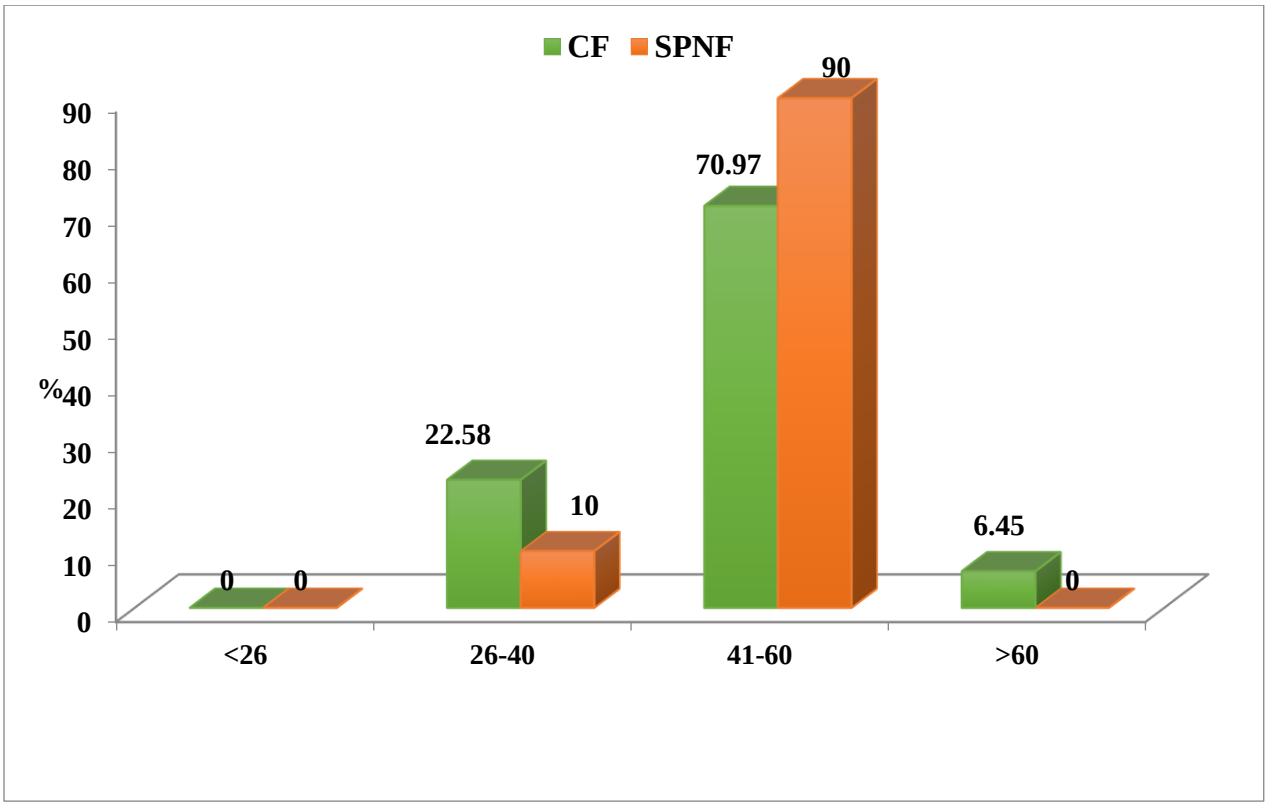

Fig.4.1 Age –wise distribution of heads of families in Subhash Palekar Natural Farming and Conventional Farming

4.4.2.2 Family members

The age-wise distribution of the family members has a significant bearing on the efficiency of the farm business as most of the farm activities are performed by members of the family, and it also helps in determining the availability of family labour. It also shows the dependency ratio and is a parameter for tailoring policy implications relating to socio-economic development in the region. The age-wise distribution of family members has been shown in Table 4.11. Maximum number of family members in both the categories was in the age group of 41-60. This group accounted for 28.93 and 39.55 per cent family members in CF and SPNF farms, respectively. Female population in both the farm category was lower as compared to the male population. The dependency ratio of CF families (0.49) was higher than SPNF families (0.33).

Table 4.11: Age-Wise distributions of family members on sample farms under different farming practices

(Numbers)

Sr. No.	Age group (years)	CF			SPNF		
		Male	**Female**	**Total**	**Male**	**Female**	**Total**
1	up to 5	5 (6.10)	6 (7.79)	11 (6.92)	5 (7.25)	2 (3.08)	7 (5.22)
2	6-15	15 (18.29)	7 (9.09)	22 (13.84)	5 (7.25)	6 (9.23)	11 (8.21)
3	16-25	7 (8.54)	10 (12.99)	17 (10.69)	18 (26.09)	11 (16.92)	29 (21.64)
4	26-40	23 (28.05)	21 (27.27)	44 (27.67)	10 (14.49)	9 (13.85)	19 (14.18)
5	41-60	22 (26.83)	24 (31.17)	46 (28.93)	26 (37.68)	27 (41.54)	53 (39.55)
6	>60	10 (12.20)	9 (11.69)	19 (11.95)	5 (7.25)	10 (15.38)	15 (11.19)
Total		82 (100.00)	77 (100.00)	159 (100.00)	69 (100.00)	65 (100.00)	134 (100.0)
7	Sex Ratio	939			942		
8	Dependency ratio	0.58	0.40	0.49	0.28	0.38	0.33

Note: Figures in parentheses indicates percentages to the total in each category.
CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

4.4.3 Educational Status

Education contributes to societal economic development through improving skill, general awareness, and modernisation, all of which influence the standard of living of households. It is the major factor regarding the adoption of new technology and innovation to ensure efficient allocation of scarce resources. Hence, the education level of the head and family members was studied and has been summarized in the following sub-section.

4.4.3.1 Heads of the families

The literacy among the farmers impacts agricultural activities, since; it impacts the transfer of technology into the farmers' field. Table 4.12 indicates that the majority of farmers had completed education up to senior secondary level and share of this education level in CF Families was 54.84 per cent and 53.33 per cent in SPNF. Nearly one third family members in both the categories had education up to graduation level. From the table it can be concluded that all the farmers have enough education to understand the techniques of natural and conventional farming practices.

Table 4.12: Educational status of the heads of families on sample farms under different farming practices

(Numbers)

Sr. No.	**Educational status**	**CF**	**SPNF**
1	Illiterate	-	-
2	Primary	-	-
3	Middle	1 (3.23)	-
4	Matriculation	2 (6.45)	2 (6.67)
5	Senior secondary	17 (54.84)	16 (53.33)
6	Graduation	10 (32.26)	11 (36.67)
7	Post-graduation	1 (3.23)	1 (3.33)
Total		31 (100.00)	30 (100.00)

Note: Figures in parentheses indicates percentages to the total in each category.
CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

4.4.3.2 Family members

The educational profile of the sample households by gender was studied and is shown in table 4.13. On an aggregate basis, sample farms practicing CF had a literacy rate of 87.59 per cent. In contrast, farmers practising SPNF had a slightly lower literacy rate (83.61 %). When family members were evaluated for education, maximum members (31.25 %) in CF had completed secondary school (Fig.4.2).While in case of SPNF majority (28.68 %), had attained graduation level education in SPNF and better education level was one of the major reasons for adoption of SPNF practices on their farms..

Table 4.13: Educational statuses of family members on sample farms under different farming practices

(Numbers)

Sr. No.	Particulars	CF			SPNF		
		Male	Female	Total	Male	Female	Total
1	Illiterate	10 (12.05)	8 (10.39)	18 (11.25)	10 (14.49)	10 (16.67)	20 (15.50)
2	Primary	7 (8.43)	6 (7.79)	13 (8.13)	2 (2.90)	2 (3.33)	4 (3.10)
3	Middle	4 (4.82)	6 (7.79)	10 (6.25)	-	3 (5.00)	3 (2.33)
4	Matriculation	7 (8.43)	5 (6.49)	12 (7.50)	8 (11.59)	12 (20.00)	20 (15.50)
5	Senior secondary	23 (27.71)	27 (35.06)	50 (31.25)	18 (26.09)	18 (30.00)	36 (27.91)
6	Graduation	23 (27.71)	16 (20.78)	39 (24.38)	24 (34.78)	13 (21.67)	37 (28.68)
7	Post graduation	3 (3.61)	-	3 (1.88)	2 (2.90)	-	2 (1.55)
8	Non school going	6 (7.23)	9 (11.69)	15 (9.38)	5 (7.25)	2 (3.33)	7 (5.43)
Total		83 (100.00)	77 (100.00)	160 (100.00)	69 (100.00)	60 (100.00)	129 (100.00)
9	Literacy rate (%)	87.01	88.24	87.59	84.38	82.76	83.61

Note: Figures in parentheses indicates percentages to the total in each category.
CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

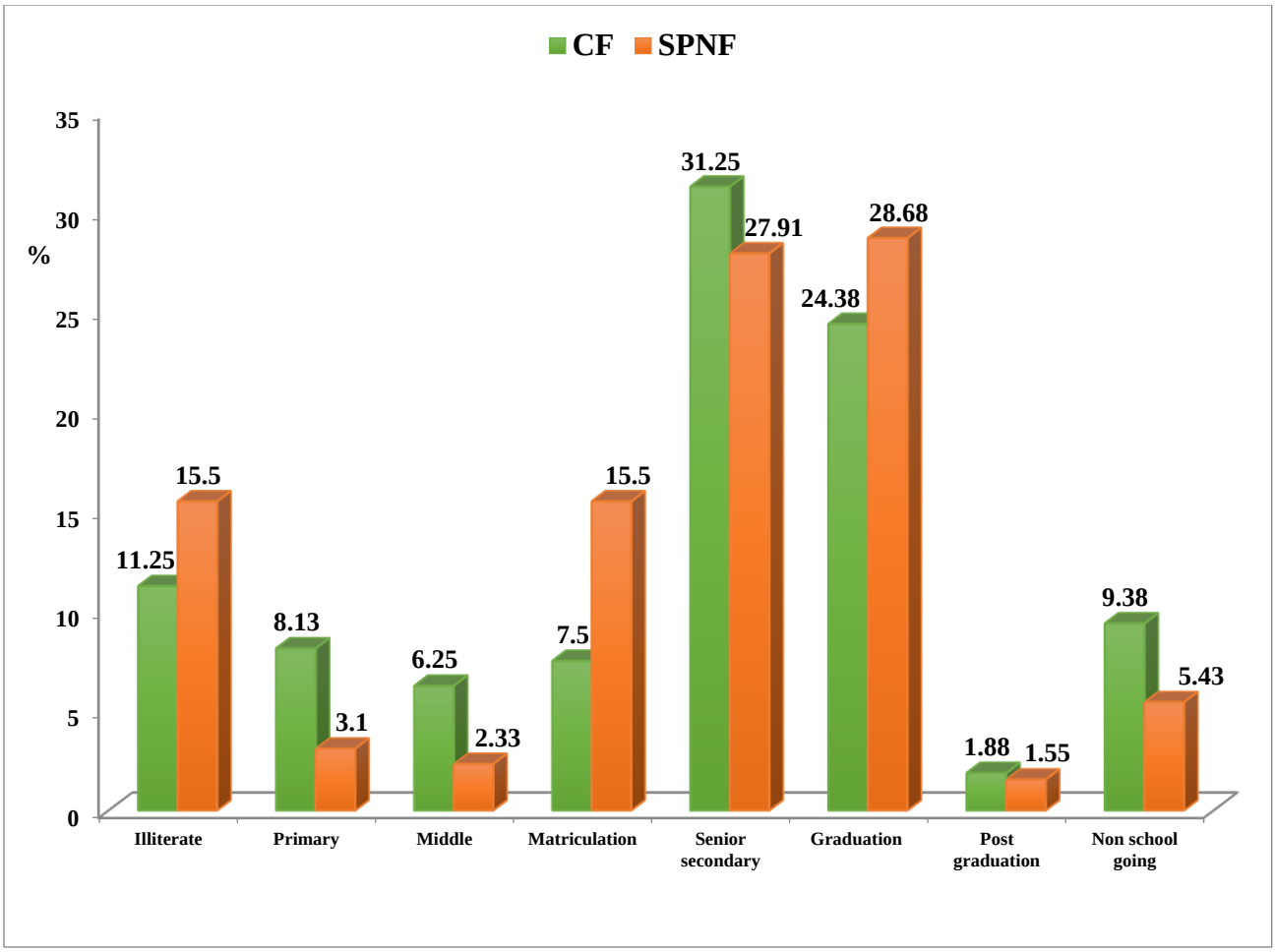

Fig.4.2 Educational status of family members under Subhash Palekar Natural Farming and Conventional Farming

4.4.4 Occupational pattern of the heads of the families on sample farms

The occupation of the family's head has a significant influence in defining the family's income and financial well-being. The occupational pattern of the working population in the research region is shown in Table 4.14. Agriculture was the primary employment for the head of the family in both farming practices, with 80.65 per cent in CF and 76.67 per cent in SPNF. Nearly one fifth of the sampled farms heads had off-farm activities as their main source of income.

Table 4.14: Occupational patterns of the heads of the families on sample farms under different farming practices

(Numbers)

Sr. No.	Occupation	CF		SPNF	
		Main	Subsidiary	Main	Subsidiary
1	Agriculture	25 (80.65)	6 (19.35)	23 (76.67)	7 (23.33)
2	Off farm activities				
i.	Govt. Services	3 (9.68)	-	3 (10.00)	-
ii.	Business man	3 (9.68)	-	2 (6.67)	-
iii.	Pensioner	-	-	2 (6.67)	
Total		31 (100.00)	6	30 (100.00)	7

Note: Figures in parentheses indicates percentages to the total in each category.
CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

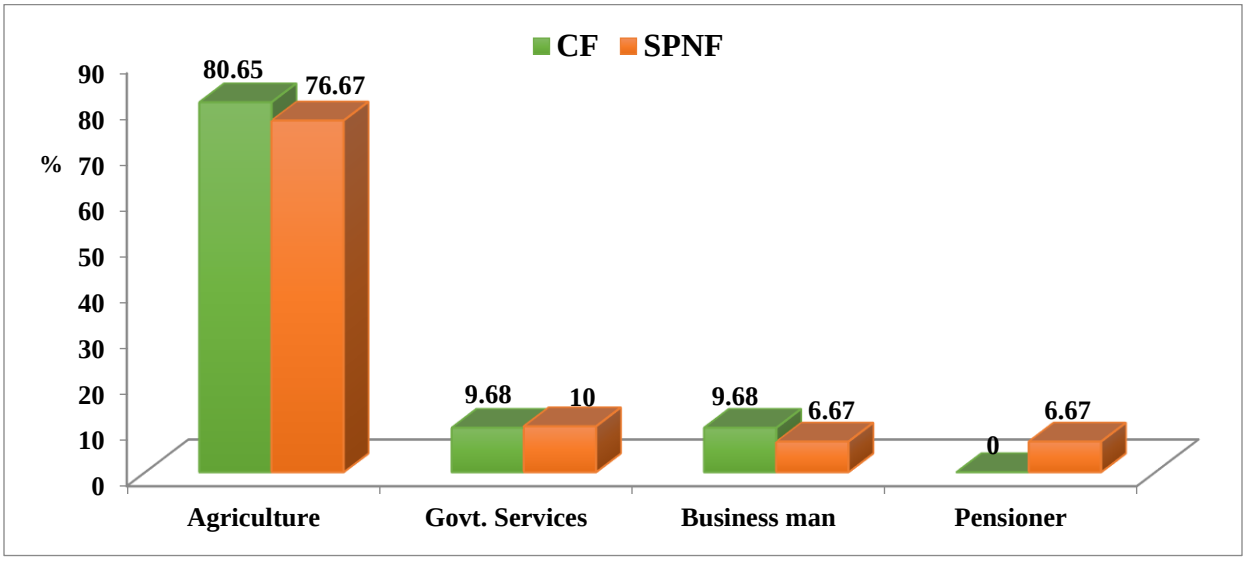

Fig.4.3 Occupational patterns of the heads of families in Subhash Palekar Natural Farming and Conventional Farming

4.5 Source-wise annual gross household income

CF and SPNF producers' annual gross household income consisted of two components i.e., farm income and off-farm income and it was calculated to be ₹ 2,60,327 and ₹ 2,82,011, respectively (Table 4.15). Farm income was the major significant contributor to annual gross income in both the farming practices, and it accounted for 78.93 and 78.48 per cent under CF and SPNF, respectively. Income from Vegetable crop production also had a sizable share in farm income and it was estimated to be 37.37 per cent in CF and 42.47 per cent in the SPNF. Dairy, with 24.64 per cent in CF and 23.26 per cent in SPNF, and field crops, with 16.93 per cent in CF and 12.76 per cent in SPNF, were the other important sources of farm income (Fig.4.4).

The results also indicated that off-farm income sources like service and business sectors also contributed significantly to annual farm income and their total contribution in total income was about 21 per cent in both the categories of farm.

Table 4.15: Source wise annual gross household's income on sample farms under different farming practices

(₹ /farm)

Sr. No.	Particulars	CF	SPNF
A	Farm income		
1	Field crops	44065 (16.93)	35973 (12.76)
2	Vegetable crops	97292 (37.37)	119781 (42.47)
3	Dairy	64132 (24.64)	65590 (23.26)
Total Farm income		205489 (78.93)	221344 (78.49)
B	Off-Farm income		
1	Service	30645 (11.77)	40000 (14.18)
2	Business	24194 (9.29)	20667 (7.33)
Total Off-Farm income		54839 (21.07)	60667 (21.51)
C	Total house hold income	260327 (100.00)	282011 (100.00)

Note: Figures in parentheses indicates percentages to the total in each category
CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

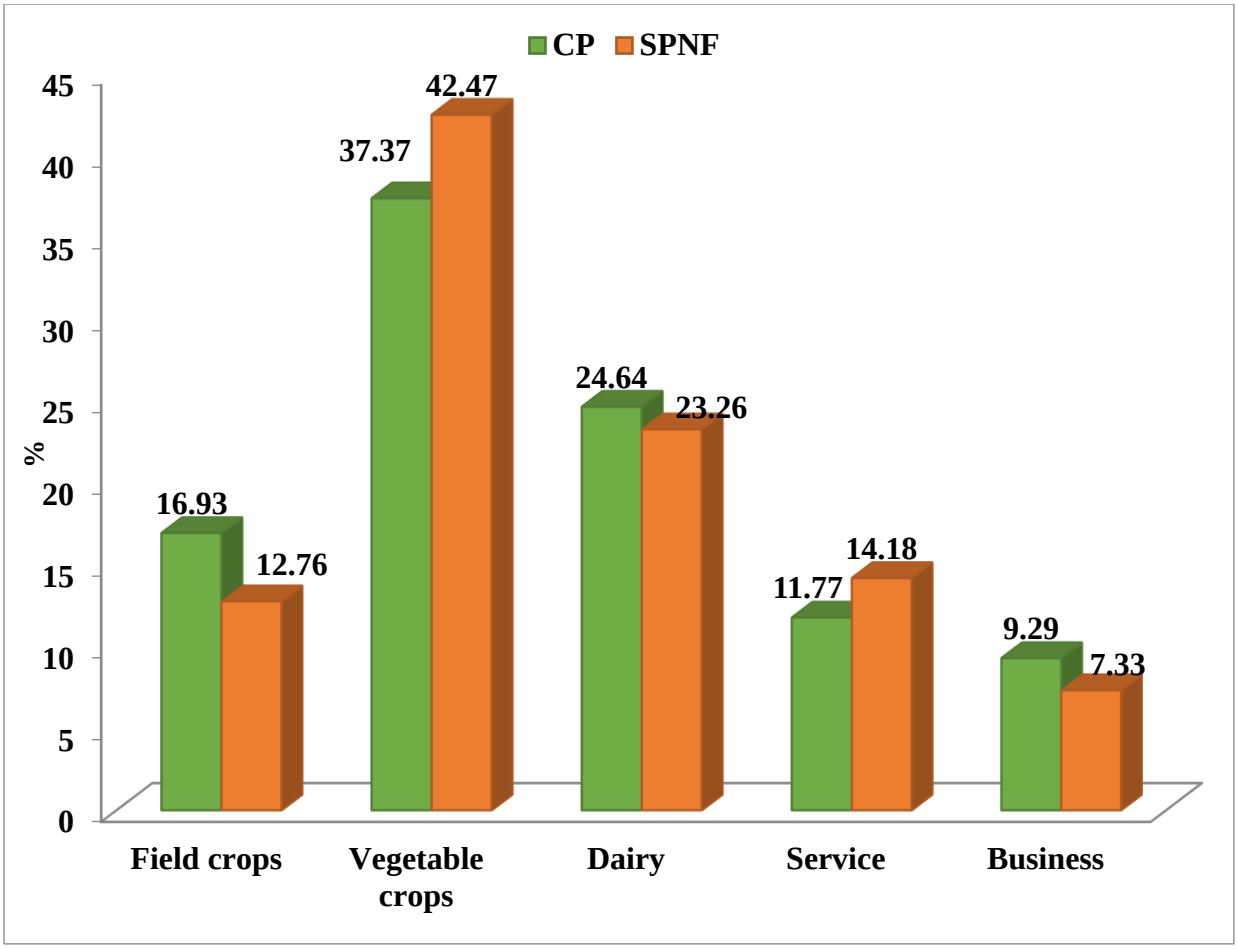

Fig.4.4 Share of different components in annual gross income of sample farm households under Subhash Palekar Natural Farming and Conventional Farming

4.6 Farm inventory and investment

This section gives details related to livestock, farm buildings, farm implements and machinery of the sample farms under different farming practices.

4.6.1 Livestock inventory and investment

Animal farming must be combined with crop production to generate sustainable income and reap the benefits of their complementary relationship. On one hand, the crop by-product is the main source of animal fodder, while on the other hand farmyard manure play vital role in maintaining the fertility and soil properties. Table 4.16 displays the inventory and worth of farm animals in the study area. Farmers retained an average of 8.26 animals on CF and 5.47 animals in SPNF farms category. Cows accounted for 20.12 per cent of animal inventory and most were

popular animal among SPNF farmers with an investment of 34.79 per cent of total investment. Natural farming is centered around inputs prepared from urine and dung of indigenous cows, this is reason for higher proportion of cattle in SPNF farm category. All families in SPNF category had their own indigenous cow in the sampled farms. In comparison, buffaloes (20.70 %) were popular livestock among Conventional Farms with a share of 44.22 per cent in total livestock investment. Goat rearing was similarly prominent in both farming systems, accounting for about 43.69 per cent of total livestock investment in CF and 43.23 per cent in SPNF farms. Livestock assists in meeting the family's milk and meat requirement while also providing a regular source of income through after sale of milk and meat products. None of the farms in the study area owned bullocks as their maintenance on farms was proving uneconomical to the farmers, mostly small and marginal farmers.

Table 4.16: Inventory-cum-investment on livestock on sample farms under different farming practices

(per farm)

Sr. No.	Particulars	No./farm		Value(₹/farm)	
		CF	SPNF	CF	SPNF
1	Cows	0.61 (7.38)	1.1* (20.12)	19452 (10.89)	39700 (34.79)
i	Indigenous cows	0.32 (3.87)	1.1 (20.12)	8710 (4.87)	39700 (34.79)
iii	Exotic cows	0.29 (3.51)	-	10742 (6.01)	-
2	Heifer	0.26 (3.13)	0.27 (4.88)	710 (0.40)	800 (0.70)
3	Buffaloes	1.71 (20.70)	0.47 (8.54)	79032 (44.22)	22667 (19.86)
4	Calves	0.26 (3.13)	0.23 (4.27)	1452 (0.81)	1617 (1.42)
5	Goats	2.42 (29.30)	1.53 (28.05)	48387 (27.08)	30667 (26.87)
i	Kids	3.00 (36.33)	1.87 (34.15)	29677 (16.61)	18667 (16.36)
Average livestock unit		8.26 (100.00)	5.47 (100.00)	178710 (100.00)	114117 (100.00)

Note: Figures in parentheses indicates percentages to the total in each category
* Rs25,000/- given as subsidy to buy cow in SPNF
CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

4.6.2 Investment on farm implements and machinery

Farm implements and machinery is an important indicator of stock and capital formation in agriculture. These farm implements are used by the farming community to perform various farm operations. Keeping this in view, farm implements inventory and investment on them was studied and the results have been presented in Table 4.17.In absolute terms, the average investment in agricultural equipment and machinery on Conventional Farms was ₹56,146, whereas, in SPNF, it was ₹38,297. The average investment in major implements was 65.32 per cent on Conventional Farms against 62.01 per cent in SPNF. In comparison, the average investment in minor implements was 34.68 per cent in Conventional Farms and 37.99 per cent in SPNF. As indicated in Table 4.16, bullocks were no longer being reared in the study area and ploughing and threshing of crops being carried by machines particularly power tillers, In Conventional Farms, the share of power tiller in total investment was 32.58 per cent, whereas, in SPNF, investment was 36.77 per cent. The most significant investment in minor tools was made in water storage structures, which accounted for 20.11 per cent in Conventional Farms and 17.41 per cent in SPNF. Other vital pieces of equipment were sickles, plankers, water buckets, baskets, and so on.

Table 4.17: Investment pattern of farm machineries and tools of sample farms under different farming practices

(per farm)

Sr. No.	Particulars	No./farm		Value(₹/farm)	
		CF	SPNF	CF	SPNF
1	Major implements				
i.	Tractor	0.03 (0.09)	-	9677 (17.24)	-
ii.	Power tiller*	0.58 (1.66)	0.33 (1.10)	18290 (32.58)	14083 (36.77)
iii.	Chaff-cutter	0.71 (2.03)	0.93 (3.08)	6516 (11.61)	7800 (20.37)
iv.	Thresher	-	-	-	-
v.	Sprayer	1.13 (3.22)	0.93 (3.08)	2194 (3.91)	1867 (4.87)
A	Sub total	2.45 (7.00)	2.20 (7.27)	36677 (65.32)	23750 (62.01)
2	Minor implements				
i.	Plough				

Contd.

Sr. No.	Particulars	No./farm		Value(₹/farm)	
		CF	SPNF	CF	SPNF
1	Wooden plough	0.81 (2.30)	0.93 (3.08)	242 (0.43)	280 (0.73)
2	M.B plough	1.03 (2.95)	1.00 (3.30)	2271 (4.04)	2200 (5.74)
ii.	Spade/Belcha	1.03 (2.95)	0.80 (2.64)	361 (0.64)	280 (0.73)
iii.	Hoe	1.87 (5.34)	1.63 (5.40)	281 (0.50)	245 (0.64)
iv.	Rake	0.55 (1.57)	0.33 (1.10)	165 (0.29)	100 (0.26)
v.	Sickle				
1	Small	4.52 (12.89)	4.20 (13.88)	361 (0.64)	336 (0.88)
2	Large	1.55 (4.42)	1.50 (4.96)	232 (0.41)	336 (0.88)
vi.	Axe	1.19 (3.41)	1.13 (3.74)	298 (0.53)	283 (0.74)
vii.	Planker	1.13 (3.22)	1.10 (3.63)	169 (0.30)	165 (0.43)
viii.	Kudali				
1	Small	4.52 (12.89)	4.20 (13.88)	452 (0.80)	420 (1.10)
2	Large	1.55 (4.42)	1.50 (4.96)	310 (0.55)	300 (0.78)
ix.	Irrigation pipe	7.55 (21.55)	3.87 (12.78)	1208 (2.15)	619 (1.62)
x.	Water storage structure	0.23 (0.64)	0.13 (0.44)	11290 (20.11)	6667 (17.41)
xi.	Water barrels	1.81 (5.16)	2.70 (8.92)	1084 (1.93)	1620 (4.23)
xii.	Baskets				
1	Plastic	0.94 (2.67)	0.90 (2.97)	281 (0.50)	270 (0.71)
2	Bamboo	2.32 (6.63)	2.13 (7.05)	465 (0.83)	427 (1.11)
B	Sub total	32.58 (93.00)	28.07 (92.73)	19469 (34.68)	14547 (37.99)
Total(A+B)		35.03 (100.00)	30.27 (100.00)	56146 (100.00)	38297 (100.00)

Note: Figures in parentheses indicate percentages to the total investment in each category.
*25-50% subsidy is not being included in the cost.
CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

4.6.3 Investment on farm buildings

The amount spent on buildings, farm machinery, tools, and other farm structures indicates a farm family's financial worth and stability. It determines the extent to which the farm enterprise may be run effectively. With this in mind, the pattern of farm building investment had been examined and is presented in table 4.18. In CF farms, residential construction accounts for 85.36 per cent of overall investment, but in SPNF, it accounted for 86.67 per cent. In the case of CF, investment made on cattle shed was 10.29 per cent which was comparatively higher than investment in SPNF which was 9.71 per cent. Very few farms owned separate goat shed, store house and vermicompost unit in the sampled farms. Total worth of the farm buildings was ₹ 8, 42,742 in CF and ₹ 8, 30,700 in SPNF farms.

Table 4.18: Investment on farm building on sample farms under different farming practices **(per farm)**

Sr. No	Farm Buildings	No./farm						Value(Rs/farm)					
		CF			SPNF			CF			SPNF		
		Kuchcha	Pucca	Mixed	Kuchcha	Pucca	Mixed	Kuchcha	Pucca	Mixed	Kuchcha	Pucca	Mixed
1	Residential	-	1 (29.25)	-	-	1 (33.27)	-	-	719355 (85.36)	-	-	720000 (86.67)	-
2	Cattle Shed	0.87 (25.47)	0.10 (2.83)	0.03 (0.94)	0.73 (24.40)	0.27 (8.87)	-	72258 (8.57)	11613 (1.38)	2903 (0.34)	58333 (7.02)	22333 (2.69)	-
3	Goat Shed	-	1.00 (29.25)	-	-	0.70 (23.29)	-	-	5323 (0.63)	-	-	3700 (0.45)	-
4	Store House	0.10 (2.83)	0.26 (7.55)	-	0.14 (4.59)	0.03 (1.15)	-	5161 (0.61)	18710 (2.22)	-	7000 (0.84)	2667 (0.32)	-
5	Vermicompost Shed	-	0.06 (1.89)	-	0.13 (4.44)	-	-	-	7419 (0.88)	-	-	16667 (2.01)	-
Total		3.42 (100.00)			3.01 (100.00)			842742 (100.00)			830700 (100.00)		

Note: Figures in parentheses indicates percentages to the total in each category.
CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

4.7 Land utilization pattern

The land is the essential component of production, especially in agriculture, where it is also the most constrained. The varied uses of land in a specific location or region reflect the various choices the people make. The amount of the holding that a farmer possesses reveals the farming family's primary strength, and its use defines his family's economic stability. Table 4.19 shows the land use across the sample households.

The average size of landholding under CF and SPNF were 1.46 and 0.82 ha, respectively. In CF, the average cultivated area was 1.12 ha, accounting for 76.44 per cent of total landholdings while in SPNF, the respective figures were 0.69 ha, and 85 per cent. Compared to SPNF (0.54 ha), CF (0.86 ha) had higher irrigated area. Other than agriculture, grassland was another category of the land owned in both farm categories.

Table 4.19: Land inventory and utilization pattern of sample farms under different farming practices

(ha/farm)

Sr. No.	Particulars	CF			SPNF		
		IR	UIR	Total	IR	UIR	Total
i.	Cultivated land	0.86 (99.41)	0.25 (42.70)	1.12 (76.44)	0.54 (100.00)	0.15 (55.17)	0.69 (84.85)
ii.	Orchard	0.01 (0.59)	-	0.01 (0.35)	-	-	-
iii.	Land put to non-agri use	-	0.02 (3.49)	0.02 (1.41)	-	0.02 (6.78)	0.02 (2.29)
iv.	Wasteland	-	0.06 (9.46)	0.06 (3.83)	-	0.02 (7.27)	0.02 (2.46)
v.	Pasture	-	0.26 (44.36)	0.26 (17.97)	-	0.08 (30.78)	0.08 (10.40)
Total land holding		0.87 (100.00)	0.59 (100.00)	1.46 (100.00)	0.54 (100.00)	0.28 (100.00)	0.82 (100.00)

Note: Figures in parentheses indicates percentages to the total in each category.
IR-Irrigated UIR-Unirrigated

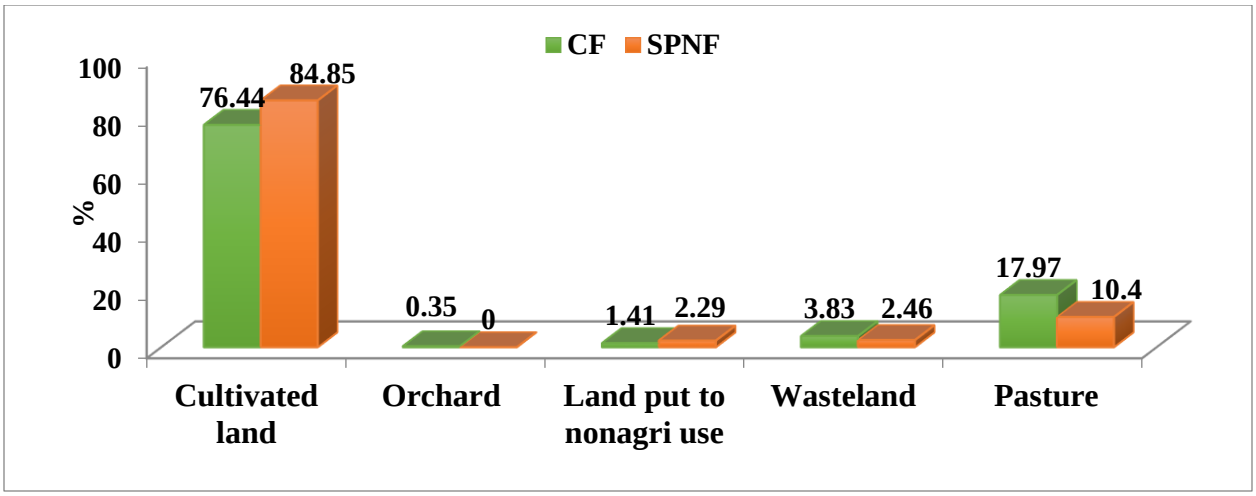

Fig.4.5 Land utilization pattern in Subhash Palekar Natural Farming and Conventional Farming

4.8 Cropping pattern and productivity

This segment has attempted to study the existing cropping pattern and productivity of different crops in the study area and the results have been summarized under the following sub-sections:

4.8.1 Cropping pattern on sample farms

The cropping pattern of a particular area reveals how much of the total cropped area is allocated to different crops at any given time. Cropping patterns must be studied to understand the pattern in the area allocated to different crops, which reveals the relative significance of crops. Table 4.20 shows the cropping patterns of farmers in the study region. In both farming practices, maize dominated the cropping pattern during the *Kharif* season, while wheat dominated the cropping pattern during the *Rabi* season. Maize accounted for 29.81 per cent of total sown area in CF and 30.57 per cent in SPNF in the *Kharif* season. Wheat accounted for 45.09 per cent of total cultivated area in CF and 46.55 per cent in SPNF during the Rabi season. The area under vegetable crops *Kharif* season *viz a vizRabi* season was higher in the in both farm categories. Proportion of area under elephant foot yam crop and its seed production was 9.17 per cent and 3.31 per cent, respectively on CF farms. Under SPNF farms, the share of elephant foot yam in total cultivated area was 11.61 per cent while its seed production accounted for 2.88 per cent. In SPNF, companion crops were also grown with the main crop in a cropping pattern like soybean and black gram with maize; Pea, Chickpea and Rapeseed & Mustard with Wheat.

Cropping intensity was found to be higher in the case of SPNF (194.12 %) as compared to CF (182.14 %).

Table 4.20: Cropping pattern of sample farms under different farming practices

(ha/farm)

Sr. no.	Particulars	CF		SPNF		Companion Crops
		Area	Per cent	Area	Per cent	
A	*Kharif*					
1	Cereal crops					
i.	Maize	0.60	(29.81)	0.41	(30.57)	Soyabean, Black Gram
ii.	Paddy	0.13	(6.24)	0.03	(2.58)	-
2	Pulses					
i.	Black gram	0.03	(1.27)	-	-	-
3	Oilseeds					
i.	Sesamum	0.03	(1.66)	0.01	(0.79)	-
4	Vegetable and spice crops					
i.	Elephant foot yam	0.19	(9.17)	0.16	(11.61)	Maize, Green gram, Soyabean
ii.	Elephant Foot Yam seed	0.07	(3.31)	0.04	(2.88)	Maize
iii.	Ginger	0.02	(1.06)	0.01	(0.89)	-
iv.	Other crops	0.05	(1.82)	0.04	(2.43)	-
	Sub total	1.11	(54.78)	0.70	(51.96)	
B	*Rabi*					
1	Cereal crops					
i.	Wheat	0.91	(45.09)	0.63	(46.55)	Pea, Chickpea, Rapeseeds & Mustard
2	Vegetable & spice crops	0.01	(0.13)	0.02	(1.49)	-
Sub total		0.92	(45.22)	0.65	(48.04)	
Total Cropped area		2.04	(100.00)	1.34	(100.00)	
Net Sown area		1.12		0.69		
Cropping intensity (%)		182.14		194.12		

CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

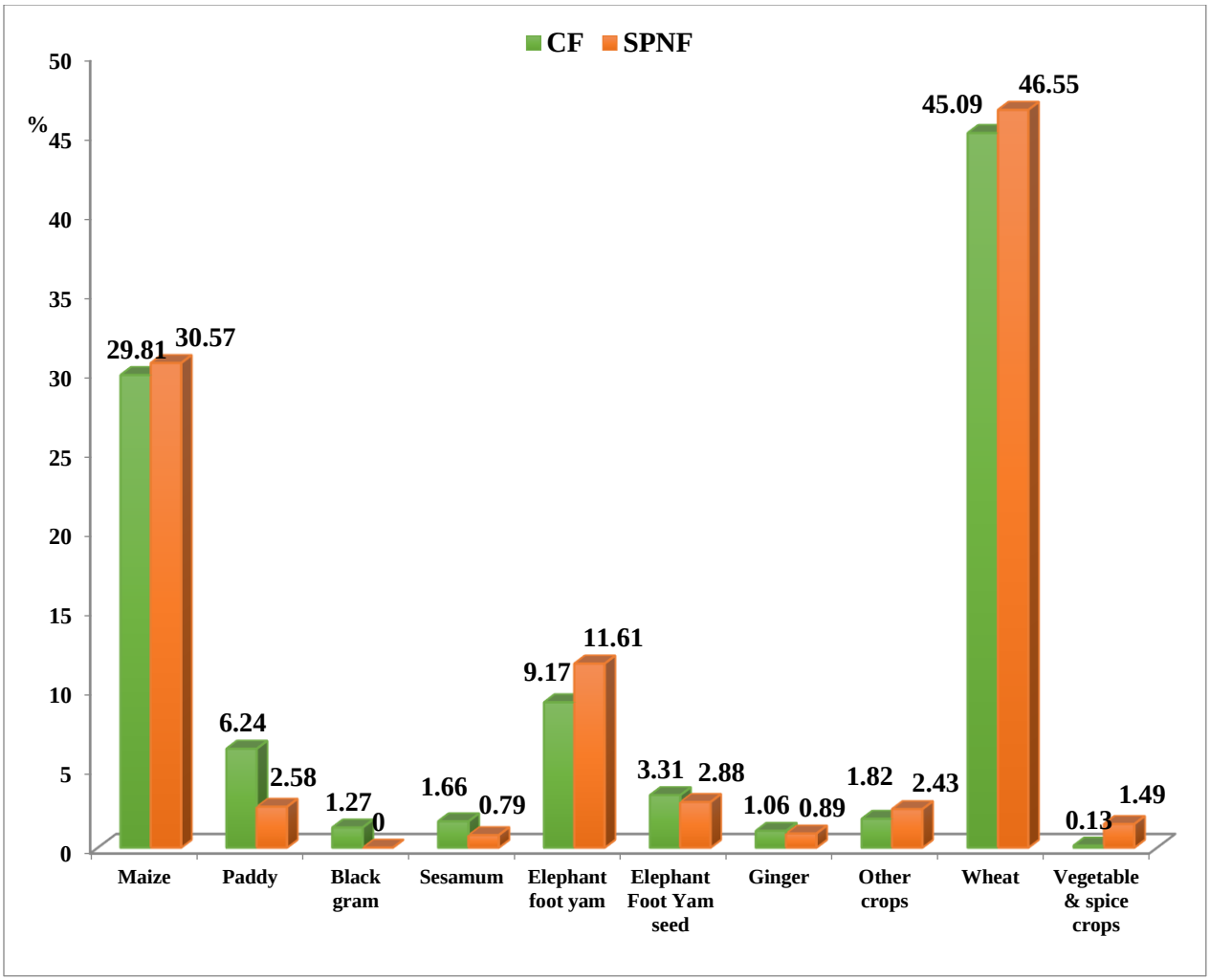

Fig.4.6 Cropping pattern under Subhash Palekar Natural Farming and Conventional Farming

4.8.2 Productivity of crop on sample farms

The average yield of different crops has been presented in table 4.21. In SPNF, companion crops were essential part of the farming technique and their yields needs to be converted into crop equivalent yield of the main crops to make comparison with sole crop under CF. Among all the crops, elephant foot yam had the highest productivity of 307.73 quintals per ha and 305.28 quintals per ha in both CF and SPNF, respectively. Companion crops grown with elephant foot yam were maize, green gram, and soybean. Maize crop, which has the maximum area under cultivation in Kharif season, had a productivity of 28 quintals per ha in Conventional Farms, Under SPNF, maize productivity was low compared to CF. But conversion of the yields

of companion crops grown with maize under SPNF into crop equivalent yield of maize, reveled higher productivity i.e., 32 quintals per ha.

Similarly, during the *Rabi* season, the crop equivalent productivity in terms of wheat was higher under SPNF cultivation (27.01 q/ha) against sole crop under CF (25.0 q/ha). Companion crops grown with maize were soybean, black gram, whereas with wheat they were pea, chickpea, and rapeseeds & mustard.

Table 4.21: Productivity of different crops of sample farms under different farming practices

(q/ha)

Sr. no.	Particulars	CF	SPNF
A	*Kharif*		
1	Cereal Crops		
i.	Maize*	28.00	32.00
ii.	Paddy	31.25	28.75
2	Pulses		
i.	Black Gram	6.25	-
3	Oilseeds		
i.	Sesamum	6.00	5.50
4	Vegetable and Spice Crops		
i.	Elephant Foot Yam*	307.73	305.28
ii.	Elephant Foot Yam corms*	103.13	108.5
iii.	Ginger	150.00	137.50
5	Companion Crop		
i.	Maize	-	0.95
ii.	Soybean	-	3.60
iii.	Black Gram	-	3.47
iv.	Green Gram	-	1.27
B	*Rabi*		
1	Cereal Crops		
i.	Wheat*	25.00	27.01
2	Companion Crop		
i.	Rapeseeds Mustard		1.24
ii.	Pea	-	1.67
iii.	Chickpea	-	1.60

* -Crop equivalent yield is calculated with companion crops in SPNF
CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

4.9 Costs and Returns

In terms of developing good production plans and formulating price policy, a study of resource usage and returns is critical. The kinds of technology on the farm and the degree and magnitude with which the different technical aspects of production are utilized in the production process have a significant impact on agricultural output. The enterprise costs and returns analysis can also help improve agricultural efficiency by providing relevant information. This part attempts to illustrate and compare the resource usage patterns and economics of various crops cultivated by families in different agricultural systems.

4.9.1 Input use pattern

Conventional agriculture and SPNF are input-intensive but in CF they sourced from market while in SPNF they are made on farms from the locally available sources. The input consumption pattern also reflects the technological aspect of the practices being used on the farm. Table 4.22 compares and contrasts the use of various inputs in various crops using both farming practices and it revealed inputs such as seed, farmyard manure, fertilizers, and human labor varied significantly across the multiple crops produced. The table further revealed that the seed rate for elephant foot yam in CF was 2437 kg per ha, against 2484 kg per ha in SPNF. In contrast, the seed required to produce elephant foot yam corms in CF was 222 kg per ha and 221.12 kg per ha in SPNF. In both traditional and SPNF methods, chemical fertilizers were not applied to cultivate elephant foot yam and elephant foot yam corms. Share of *Jivaamrit* and ploughing charges were greater in SPNF in elephant foot yam and corm production than other SPNF inputs.

The seed rate for maize was 17.28 kg per ha and 19.40 kg per ha in CF and SPNF, respectively. Higher seed rate in SPNF can be attributed to the practice of broadcasting in SPNF against line sowing in CF. Along with FYM, fertilizers were also used in maize in CF systems. The wheat seed rate is 132.56 kg per ha in CF and 147.31 kg per ha in the case of SPNF. Organic manure, i.e., FYM, is being used in CF with fertilizers, whereas in SPNF, no chemical inputs were being used.

Organic manure, i.e., FYM, was being used by farmers under CF in all the crops. Fertilizers like urea in maize fields, and IFFCO was along with urea in wheat production were

being used in CF. Both FYM and fertilizers were not being used in the SPNF. Mulching is the main component of SPNF practices for water management and weed control, hence its use under SPNF crops was found to be on higher side in each crop.

Gajendra Variety

Local Variety

Plate 2:Visit to Elephant Foot Yam field

Gajendra Variety

Local Variety

Plate 3:Elephant Foot Yam variety grown in Study Area

Table 4.22: Input use pattern for different crops on sample farms under different farming practices

(per ha)

Sr. No	Particulars	Elephant foot yam		Elephant foot yam corms		Maize		Wheat	
		CF	SPNF	CF	SPNF	CF	SPNF	CF	SPNF
1	Corms/Seed (kg)	2437	2484	222	221.12	17.28	19.40	132.56	147.31
2	FYM (q)	192.36	-	40	-	52.62	-	61.33	-
3	Ploughing (hrs)	16.48	18.96	17.33	18.21	11.00	11.00	12.84	12.78
4	SPNF Input								
i.	*Jeevamrit (ltr)*	-	735.04	-	633.62	-	650.16	-	697.11
ii.	*Beejamrit (ltr)*	-	250	-	100	-	6.25	-	25.00
iii.	*GhanaJeevamrit (q)*	-	10.93	-	7.33	-	5.16	-	10.00
iv.	*Neemastar (ltr)*	-	3.75	-	3.75	-	3.75	-	3.75
v.	*Dreakastra (ltr)*	-	3.75	-	3.75	-	3.75	-	3.75
Vi	*Tammer Lassi (ltr)*	-	14.37	-	14.44	-	14.20	-	14.29
5	Fertilizers								
i.	Urea (kg)	-	-	-	-	152.51	-	154.73	-
ii.	IFFCO Mixture (kg)	-	-	-	-	-	-	224.26	-
6	Plant protection measures	-	-	-	-	-	-	-	-
7	Mulching (q)	78	90	83	85	55	70	75	80

CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

4.9.2 Operation wise labour utilization in different crops on sample farms under different farming practices.

Agriculture because of its labour-intensive nature is the major source of employment generation in our country. Labor was one of the most significant and critical resources required for elephant foot yam, production. Table 4.23 depicts the labor use pattern for various crops grown by sample farms. In elephant foot yam production labor requirement was highest in the case of weeding, accounting for 53.24 per cent and 41.24 per cent of total labor in CF and SPNF, respectively. Elephant foot yam and its corm production required a significant portion of labour for manual weeding as they do not use any weedicides to control the weed. Compared to CF, SPNF farms used less labor for weeding as more area was covered undermain crop and companion crops leaving little scope for weed growth. Thus, helping in coping with the weed problem to some extent. Harvesting was another labour-intensive operation in elephant foot yam accounting for 24.13 per cent and 21.75 per cent in both CF and SPNF, respectively. Total labor days for elephant foot yam production were found to be 245 days in CF and 265 days in SPNF.

Weeding, being the highest labor utilizing component in corm production, accounted for 61.68 per cent in CF and 49.76 per cent in SPNF, followed by harvesting as the second-highest labour-intensive component, accounting for 21.93 per cent in CF and 19.71 per cent in SPNF. Total labor days requirement for elephant foot yam corm production were 274 days and 286 days in CF and SPNF, respectively.

In maize, harvesting was highest labor consuming operation, accounting for 42.33 per cent and 28 per cent of total labor days, i.e., 66 days and 100 days under CF and SPNF farming, respectively. After harvesting, FYM application was the second labor intensive operation in CF and it accounted for 18.90 per cent of total labor use. In SPNF, the *Jeevamrit* application was the second-highest component accounting for 18.75 per cent since this operation was being carried after an interval of 2 to 3 weeks. In wheat, total labor requirement was74 man days for CF and 111 man days for SPNF. Harvesting was the significant component of total labor usage in wheat production, accounting for 39.39 per cent in CF and 26.19 per cent in SPNF. It was followed by disposal of FYM application as the next labour-intensive operation in CF accounting for 25.46 per cent and application of *Jeevamrit* and *Ghana Jeevamrit* in SPNF, both accounting for 16.93 per cent.

SPNF inputs preparation and application lead to higher labor days in SPNF compared to CF as various inputs prepared under SPNF require substantial amount of labour. Labour requirement in elephant foot yam corm production was higher than elephant foot yam production as it needs additional labour for drying of corms. Extra labour for elephant foot yam production also emerged due to manual operations like ridges preparation and planting of corms.

Plate 4:Elephant Foot Yam corm used for commercial purpose and EFY production

Table 4.23: Operation wise labour utilization in different crops cultivated by sample elephant foot yam growers

(Man Days/ha)

Sr. No.	Particulars	Elephant foot yam		Elephant foot yam corms		Maize		Wheat	
		CF	SPNF	CF	SPNF	CF	SPNF	CF	SPNF
1	Planting of corms/Sowing	6 (2.41)	6 (2.44)	7 (2.63)	7 (2.44)	7 (10.59)	8 (8.00)	8 (10.90)	9 (8.13)
2	Field preparation	3 (1.02)	3 (0.94)	3 (0.91)	3 (0.87)	3 (3.78)	4 (3.72)	3 (3.41)	3 (2.26)
3	Preparation of ridges	14 (5.76)	15 (5.51)	15 (5.44)	14 (4.88)	-	-	-	-
4	Disposal of FYM	19 (7.64)	-	9 (3.45)	-	13 (18.90)	-	19 (25.55)	-
5	Fertilizer application	-	-	-	-	4 (6.05)	-	4 (5.63)	-
6	Weeding	131 (53.24)	109 (41.24)	169 (61.68)	143 (49.76)	3 (4.54)	2 (2.00)	3 (4.09)	2 (1.81)
7	Mulching	14 (5.62)	13 (4.85)	11 (3.95)	16 (5.42)	3 (4.54)	3 (2.00)	3 (4.09)	3 (2.71)
8	Hoeing	-	-	-	-	3 (4.54)	2 (2.00)	-	-
9	Irrigation	-	-	-	-	3 (4.72)	3 (3.13)	5 (6.81)	5 (4.52)
10	SPNF inputs preparation								
i.	*Tammer Lassi*	-	-	-	-	-	-	-	-
ii.	*Beejamrit*	-	1 (0.47)	-	1 (0.44)	-	0.4 (0.38)		1 (0.68)

iii.	*Jeevamrit*	-	6 (2.28)	-	6 (2.08)	-	6 (6.02)	-	6 (5.42)
iv.	*GhanaJeevamrit*	-	7 (2.62)	-	3 (1.09)	-	3 (3.13)	-	6 (5.64)
v.	*Neemastar*	-	2 (0.57)	-	2 (0.52)	-	2 (1.50)	-	2 (1.35)
vi.	*Dreakastra*	-	2 (0.57)	-	2 (0.52)	-	2 (1.50)	-	2 (1.35)
11	SPNF inputs application								
i.	*Tammer Lassi*	-	1 (0.38)	-	1 (0.35)	-	1 (1.00)	-	1 (0.90)
ii.	*Beejamrit*	-	1 (0.38)	-	1 (0.35)	-	0.4 (0.38)	-	1 (0.66)
iii.	*Jeevamrit*	-	19 (7.07)	-	19 (6.54)	-	19 (18.75)	-	19 (16.93)
iv.	*GhanJeevamrit*	-	19 (7.07)	-	9 (3.27)	-	13 (12.50)	-	19 (16.93)
v.	*Neemastar*	-	3 (0.94)	-	3 (0.87)	-	3 (2.50)	-	3 (2.26)
vi.	*Dreakastra*	-	3 (0.94)	-	3 (0.87)	-	3 (2.50)	-	3 (2.26)
12	Plant protection	-	-	-	-	-	-	-	-
13	Harvesting & cleaning	59 (24.13)	58 (21.75)	60 (21.93)	56 (19.71)	28 (42.33)	28 (28.00)	29 (39.52)	29 (26.19)
14	Total labour days	245 (100)	265 (100)	274 (100)	286 (100)	66 (100)	100 (100)	73 (100)	111 (100)

Note: Figures in parentheses indicate percentages to the total in each category.

CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

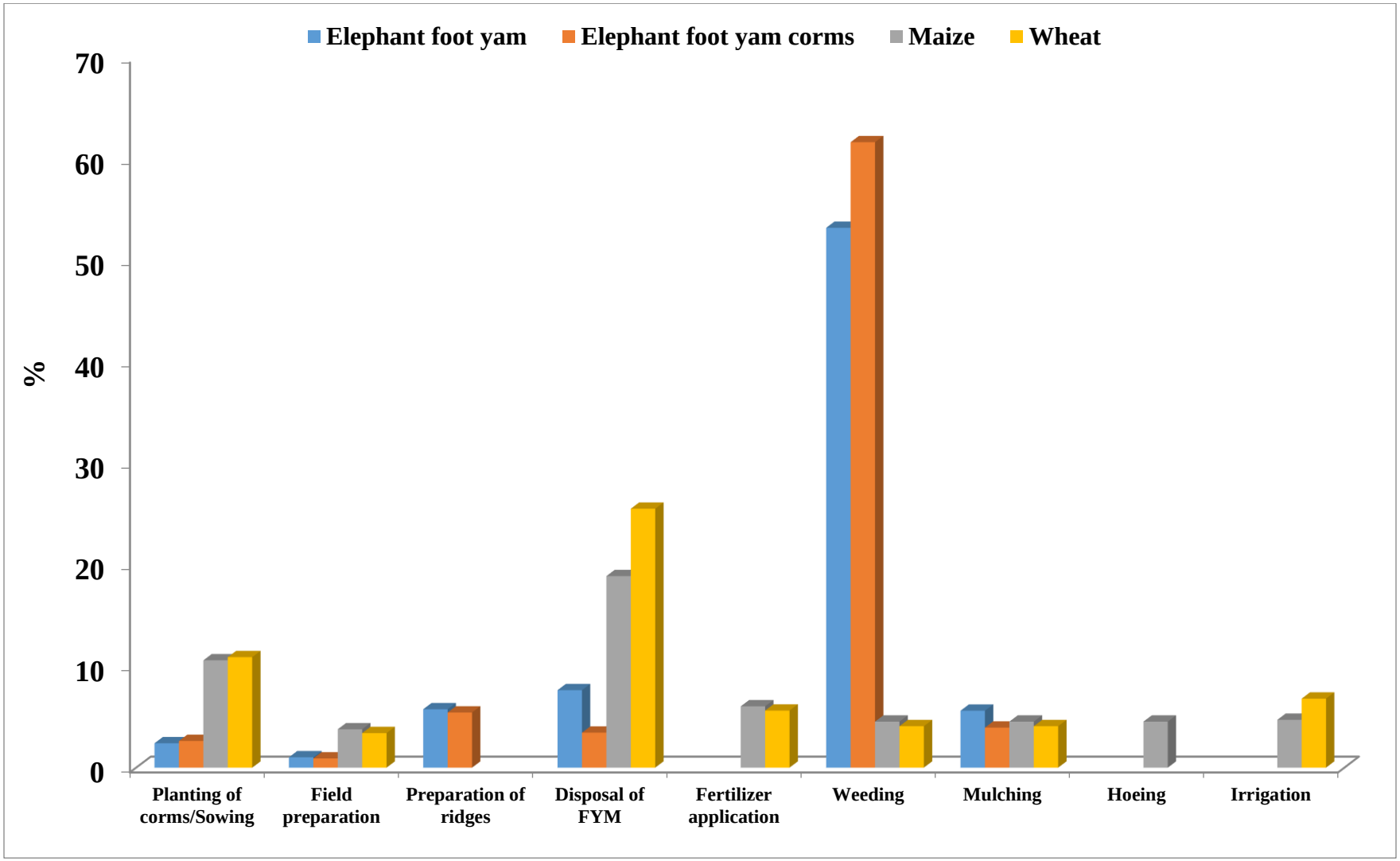

Fig.4.7 Operation wise labour utilization in different crops under Conventional Farming

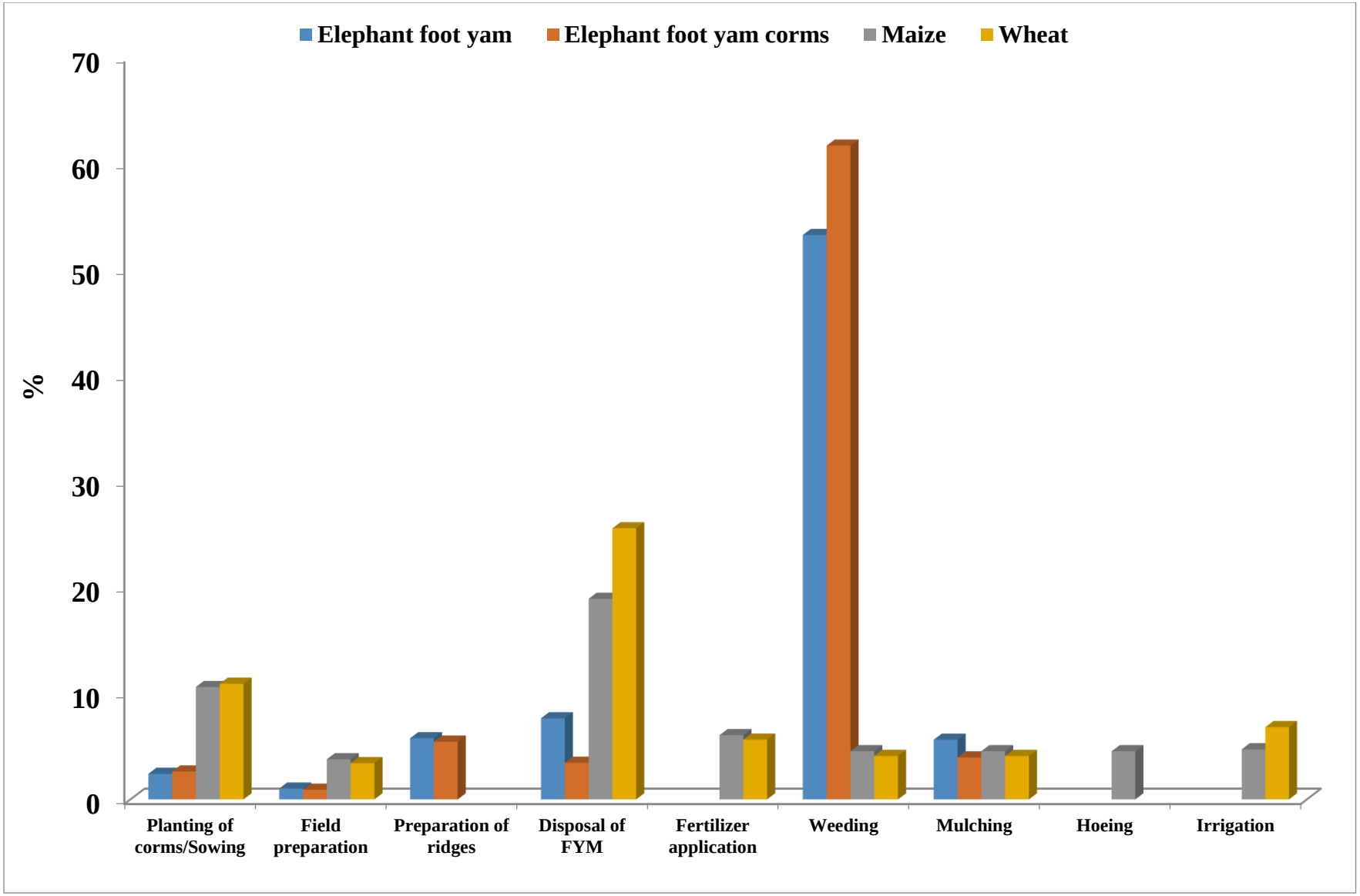

Fig.4.8 Operation wise labour utilization for different crops under SPNF farming

4.9.3 Variable cost of various crops on sample farms under different farming practices

The variable cost structure of elephant foot yam cultivation, consisting of expenditure made on seed, human labor, SPNF inputs, farmyard manure, fertilizer, etc., has been discussed in table 4.24. The total variable cost of elephant foot yam in CF was found to be higher (₹ 1, 95,947 /ha) than in SPNF (₹ 1,94,118 / ha).The analysis of different data collected from sample farms revealed that major component of variable cost in elephant foot yam production was corms accounting for 87.05 per cent in the CF and 89.57 per cent in SPNF, with a value of ₹ 1, 70,564 per ha and ₹ 1,73,878 per ha respectively. Another component of Conventional Farming variable cost was farmyard manure accounting for ₹ 9,618 per ha, with 4.91 per cent of variable costs. In SPNF, its inputs were another major component amounting to ₹ 2,604 per ha, and accounting for 1.33 per cent share in variable cost.

In elephant foot yam corm production, the cost of seed corms was the major component of the variable cost, having 64.13 per cent share in variable cost per ha in CF and 63.08 per cent in SPNF, amounting to ₹ 22,163 per ha in Conventional Farming and ₹ 22112 in SPNF. Value of farmyard manure used in CF was ₹ 2,644 per ha. In contrast, SPNF inputs worth₹ 1,724 per ha, having a share of 4.92 per cent in variable cost was used.

In maize, ploughing charges were the major contributor to variable cost in both practices accounting for ₹ 4,400 per ha contributing 27.39 per cent in CF and 27.96 per cent in SPNF. Seed worth ₹ 2,592 was used in maize in CF accounting for 16.14 per cent of variable cost. In case of SPNF maize its contribution in variable cost was 18.49 per cent amounting to ₹ 2,910 per ha. Farmyard manure and fertilizer accounted for a share of 16.38 per cent in variable cost in CF and 5.32 per cent in SPNF. SPNF inputs used in maize cultivation accounted for a share of 8.67 per cent of total variable cost.

In wheat, seeds contributed 20.62 per cent to variable cost in CF and 24.08 per cent in SPNF and were valued worth ₹ 5,302 per ha and ₹ 4,419 per ha, respectively. Farmyard manure worth ₹ 3,067 per ha was used in CF with a share of 16.38 per cent of variable cost. Fertilizers, i.e., Urea and IIFCO mixture, were valued at ₹ 867 per ha and ₹ 5 3820 per ha. In SPNF, natural farming inputs accounted for ₹ 1,656 per ha with a per cent share of 9.02.

Table 4.24: Variable cost structure of various crops cultivated by sample elephant foot yam growers

(₹/ha)

Sr. No.	Particulars	Elephant foot yam		Elephant foot yam corms		Maize		Wheat	
		CF	SPNF	CF	SPNF	CF	SPNF	CF	SPNF
1	Corms/Seed	170564 (87.05)	173878 (89.57)	22163 (64.13)	22112 (63.08)	2592 (16.14)	2910 (18.49)	5302 (20.62)	4419 (24.08)
2	FYM	9618 (4.91)	-	2644 (7.65)	-	2631 (16.38)	-	3067 (11.93)	-
3	Ploughing charges	6738 (3.44)	7585 (3.91)	6933 (20.06)	7284 (20.78)	4400 (27.39)	4400 (27.96)	5136 (19.97)	5111 (27.85)
4	Charges for SPNF Input preparation	-	2604 (1.33)	-	1724 (4.92)	-	1364 (8.67)	-	1656 (9.02)
5	Fertilizers								
i.	Urea	-	-	-	-	854 (5.32)	-	867 (3.37)	-
ii.	IIFCO mixture	-	-	-	-	-	-	5382 (20.93)	-
6	Plant protection measures	-	-	-	-	-	-	-	-
7	Depreciation charges	1491 (0.76)	2584 (1.33)	1491 (4.31)	2584 (7.37)	4969 (30.93)	6459 (41.04)	4969 (19.33)	6459 (35.20)
8	Sub Total	188411	186651	33231	33704	15446	15134	24722.01	17646
9	Interest on working capital @4%	7536 (3.85)	7466 (3.85)	1329 (3.85)	1348 (3.85)	618 (3.85)	605 (3.85)	989 (3.85)	706 (3.85)
10	Total Variable cost(8+9)	195947 (100.00)	194118 (100.00)	34560 (100.00)	35052 (100.00)	16064 (100.00)	15739 (100.00)	25710 (100.00)	18351 (100.00)

Note: Figures in parentheses indicates percentages to the total in each category.
CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

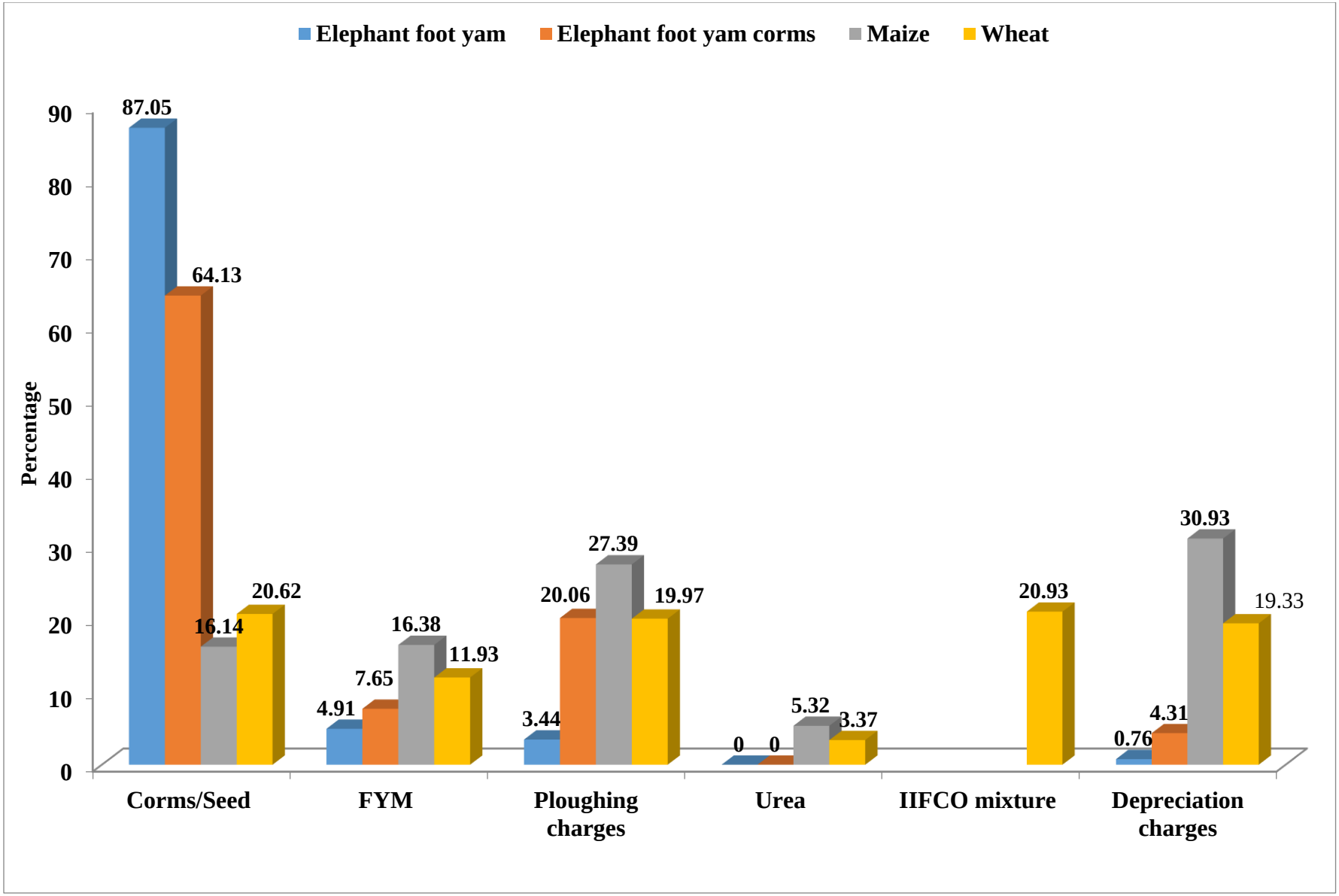

Fig.4.9 Share of various components in total variable cost in Conventional Farming

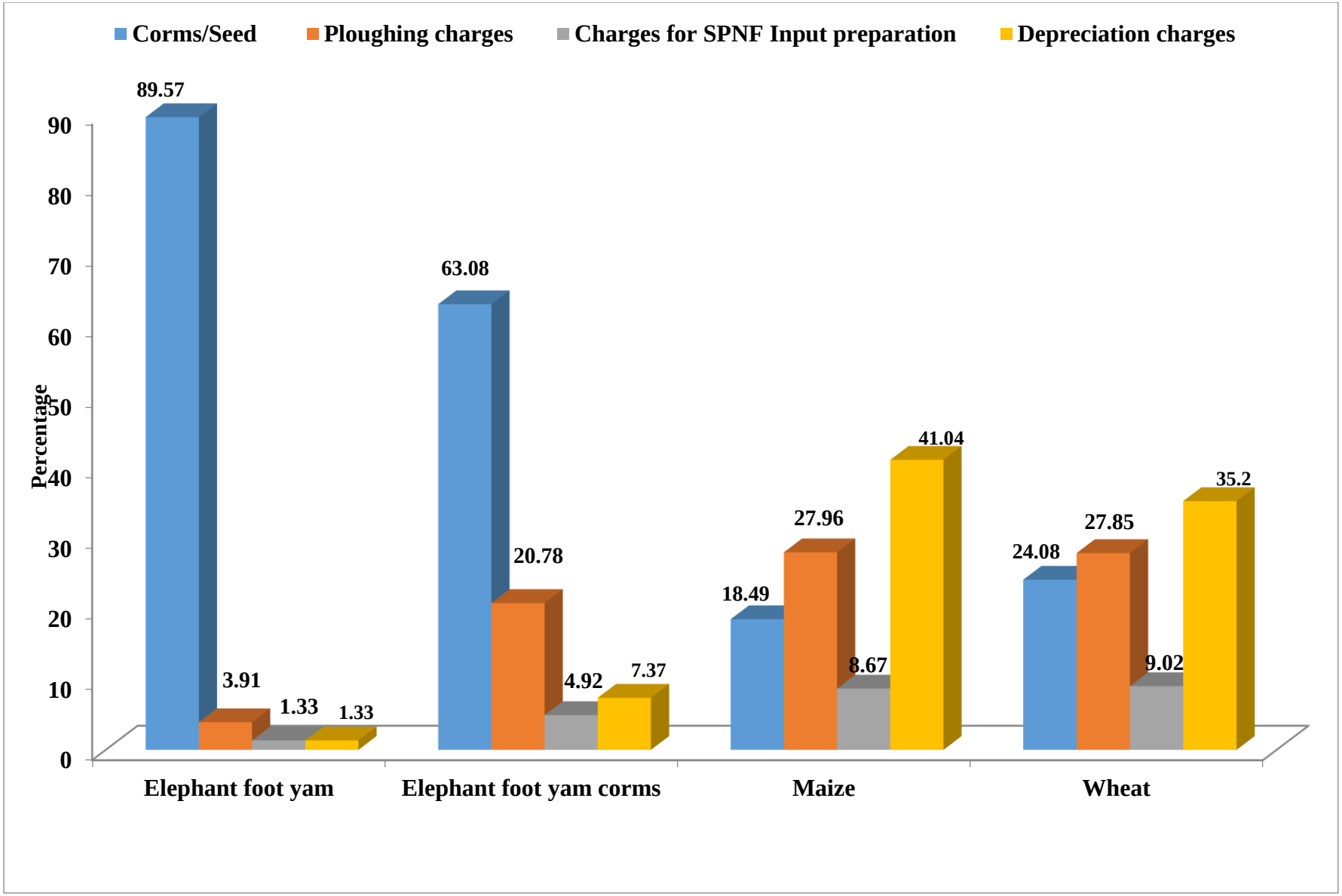

Fig.4.10 Share of various components in total variable cost in SPNF

4.9.4 Costs and returns from different crops on sample farms under different farming practices

Analysis of cost and returns is of vital importance both from the point of view of evolving sound production plans and for the formulation of price policy. The crop/enterprise cost and returns study also provide beneficial information for improving farm efficiency. The costs and returns for essential crops grown by the farmers under different farming systems were estimated and are depicted in Table 4.25. In elephant foot yam production, Total cost was ₹ 3, 11,585 per ha in CF whereas ₹ 3, 17,384 in SPNF. In CF, the gross return was valued at ₹ 9, 23,177 per ha and ₹ 9, 15,853 per ha in SPNF. Per quintals cost of production was ₹ 1,013 and ₹ 1,040 in CF and SPNF, respectively. Output input ratio was found to be 2.96 and 2.89 in CF and SPNF, respectively.

Elephant foot yam corm production cost was ₹ 1, 63,635 per ha in Conventional Farming and ₹ 1, 68,522 per ha in SPNF, respectively. Total variable cost and total fixed cost valued ₹ 34,560 and ₹ 35,052 per ha, respectively, in CF and ₹ 35,052 and ₹ 1, 33,470 per ha in SPNF, respectively. In CF, gross returns were ₹ 10, 31,250 per ha with an Output-Input ratio of 6.30 against₹ 10, 87,043 per ha in SPNF with an Output-Input ratio of 6.45. In CF, total cost of corm production was found to be ₹ 1,587 per quintals, against ₹ 1,550 per quintals SPNF.

Total cost of maize cultivation was ₹ 50,495 per ha in CF and ₹ 63,319 per ha in SPNF. The total cost of production was ₹ 1,400 per quintals in CF against₹ 1,625/q in SPNF. In CF, the output-input ratio was 1.25 against 1.11 in SPNF, with gross return valued at ₹ 62,875 per ha in CF and ₹ 70,533 per ha in SPNF. In wheat, CF had a total cost of ₹ 63,045 per ha and ₹ 70,229 per ha in SPNF. In CF, the total cost of production was ₹1,610 per quintals against₹ 1,796per quintals in SPNF. Sharma (2020) reported that in rabi season, the percentage drop in cost under NF over CF ranged from 5% to 22%, while in kharif season, it ranged from 5% to 10%.

Table 4.25: Costs and returns from different crops cultivated by sample elephant foot yam growers

(₹/ha)

Sr.No.	**Particulars**	**Elephant foot yam**		**Elephant foot yam corms**		**Maize**		**Wheat**	
		CF	**SPNF**	**CF**	**SPNF**	**CF**	**SPNF**	**CF**	**SPNF**
1	Total variable cost	195947	194118	34560	35052	16064	15739	25711	18351
2	Total fixed cost	115638	123267	129075	133470	34431	47580	37334	51877
i.	Interest on fixed capital @ 8 % p.a.	2484	2153	4472	3876	2981	2584	2981	2584
ii.	Family labor	98154	106114	109603	114594	26461	39996	29435	44294
iii.	Rental value of land	15000	15000	15000	15000	5000	5000	5000	5000
3	Total cost	311585	317384	163635	168522	50495	63319	63045	70229
4	Returns								
Production (q)		308	300	103	108	28	25	25	23
Price (₹/q)		3000	3000	10000	10000	1850	1850	1975	1975
Companion crop equivalent yield									
i.	Maize (q)	-	1	-	1	-	-	-	-
ii.	Green gram (q)	-	1	-	-	-	-	-	-
iii.	Soyabean (q)	-	3	-	-	-	4	-	-
iv.	Black gram (q)	-	-	-	-	-	3	-	-
v.	Pea (q)	-	-	-	-	-	-	-	2

vi.	Rapeseed & Mustard (q)	-	-	-	-	-	-	-	1
vii.	Chickpea (q)	-	-	-	-	-	-	-	2
Total (q)		308	305	103	109	28	32	25	28
5	By-product								
i.	Quantity (q)	-	-	-	-	30	28	38	34
ii.	Value (₹/q)	-	-	-	-	400	400	600	600
6	Gross returns	923177	915853	1031250	1087043	62875	70533	73375	77588
7	Return over total cost	611592	598469	867615	918521	12380	7214	10330	7360
8	Return over variable cost	727230	721736	996690	1051991	46811	54794	47664	59237
9	Total cost of production (₹/q)	1013	1040	1587	1550	1400	1625	1610	1796
10	Variable cost of production(₹/q)	637	636	335	322	584	491	1028	662
11	Output-Input ratio	2.96	2.89	6.30	6.45	1.25	1.11	1.16	1.10

Note: Figures in parentheses indicate percentages to the total in each category.
CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

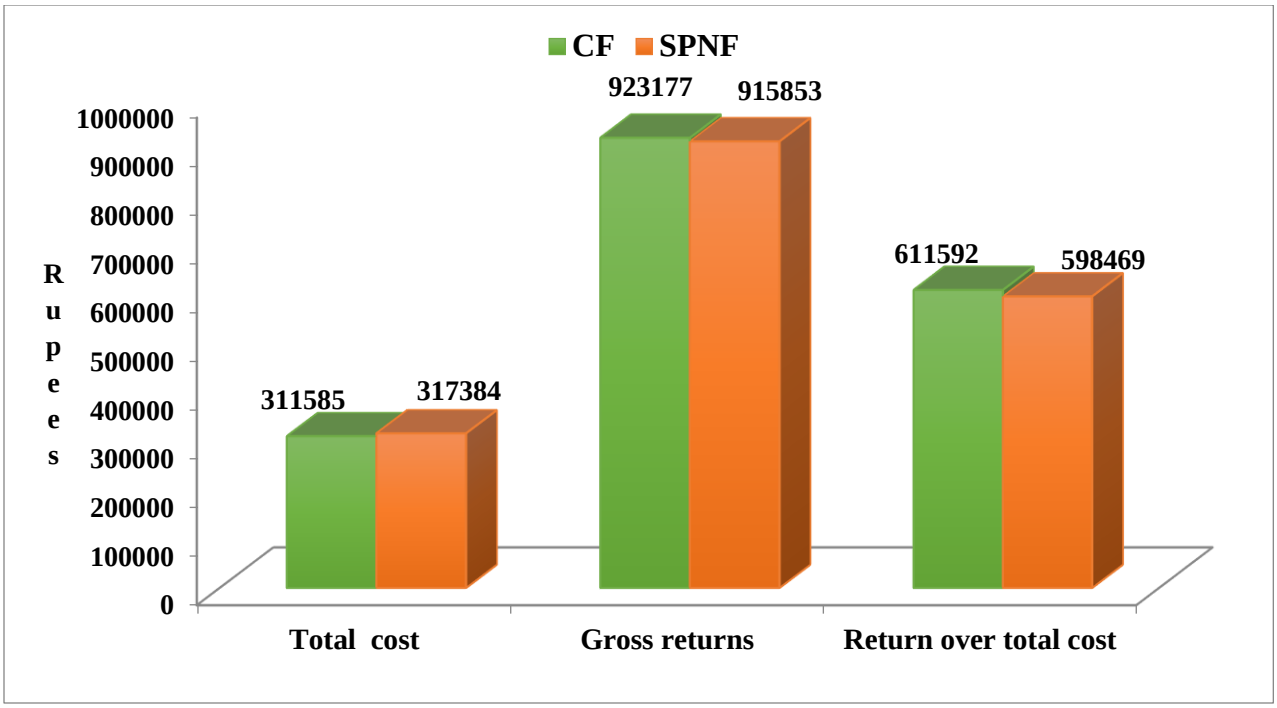

Fig.4.11 Cost and Returns from Elephant foot yam under SPNF and Conventional Farming

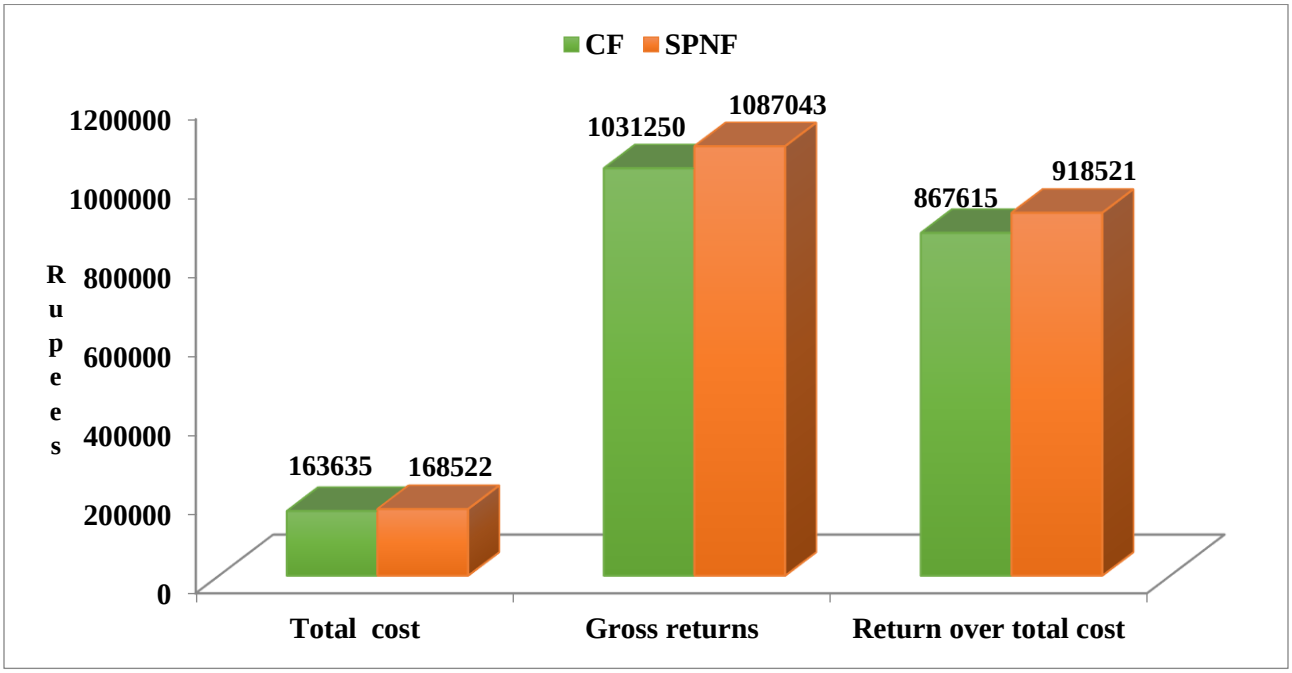

Fig.4.12 Cost and Returns from Elephant foot yam corm production under SPNF and Conventional Farming

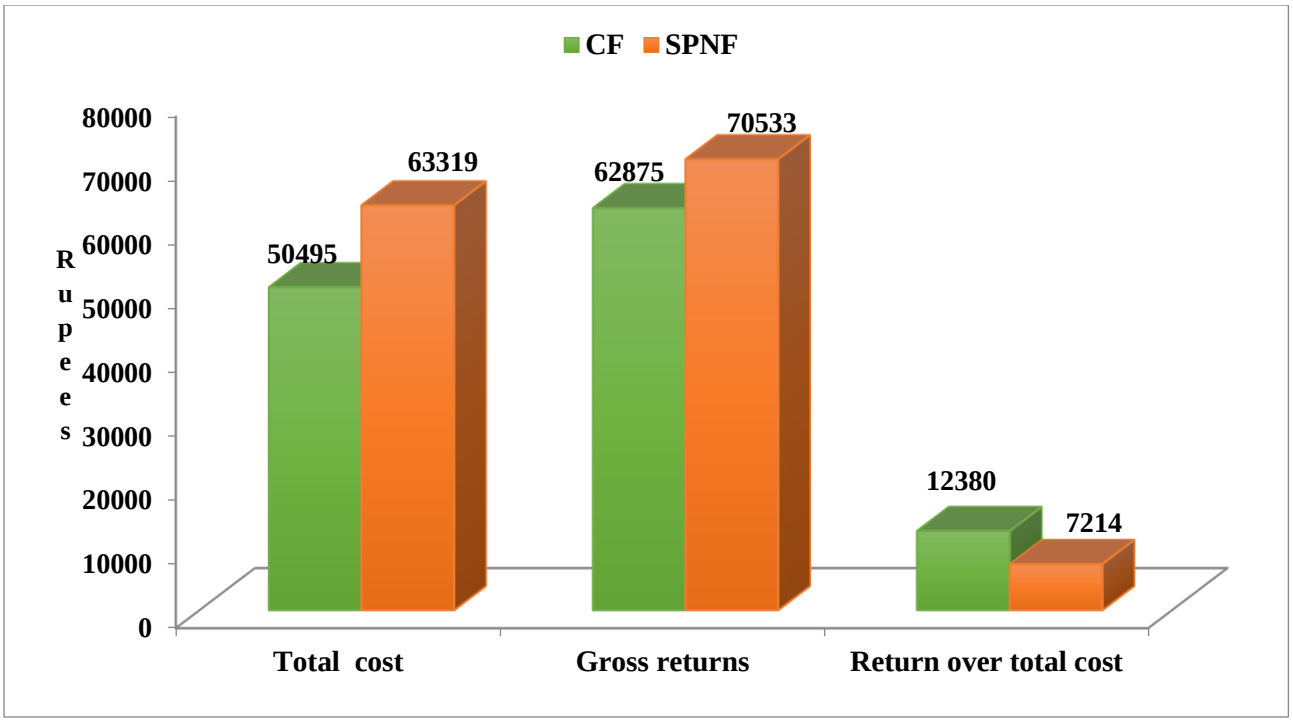

Fig.4.13 Cost and Returns from Maize under SPNF and Conventional Farming

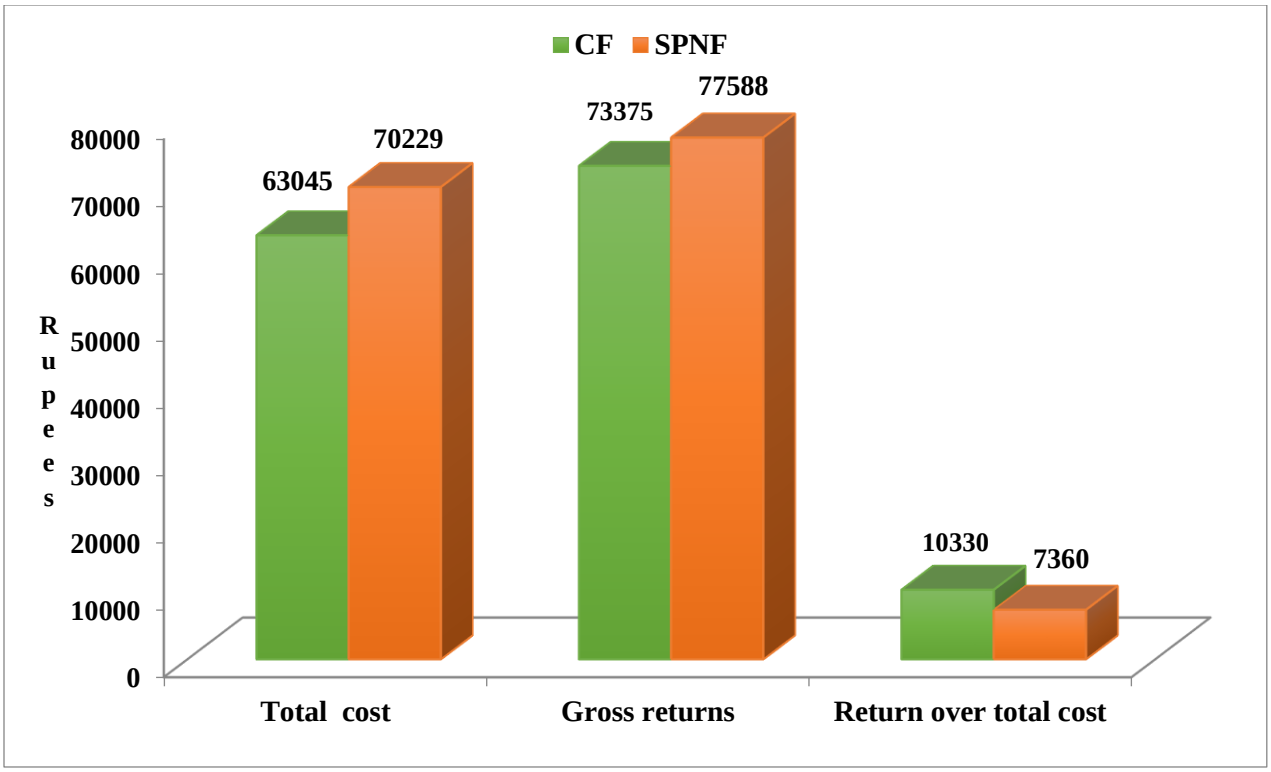

Fig.4.14 Cost and Returns from Wheat under SPNF and Conventional Farming

4.9.5 Different farm management costs and returns in different crops on sample farms under different farming practices.

The cost and returns from various crops under different categories are presented in table 4.26. Table showed that on an average farm, Operational cost (Cost A), of elephant foot yam was estimated ₹1, 95,947 per ha and ₹ 1,94,118 per ha in CF and SPNF, respectively. In CF, the total cost (Cost D) was ₹ 3, 42,744 per ha and ₹ 3, 49,123 per ha in SPNF. In CF, gross returns from elephant foot yam were ₹ 9, 23,177 per ha and ₹ 9, 15,853 in SPNF. The net returns over total Cost A were ₹ 7, 27,230 per ha in CF and ₹ 7, 21,736 per ha in SPNF. In elephant foot yam corm production, the average total cost (Cost D) per ha was ₹ 1, 79,999 and ₹ 1, 85,375 in CF and SPNF, respectively. The net return over Cost D were ₹ 8, 51,251 per ha and ₹ 9,01,669 per ha in CF and SPNF, respectively.

In Maize, average total cost (Cost D) was ₹ 55,544 per ha and ₹ 69,651 per ha in CF and SPNF, respectively. The net return over Cost D were₹ 7,331 per ha and ₹ 882 per ha in CF and SPNF, respectively. In Wheat, average total cost (Cost D) was₹ 69,349 per ha and ₹ 77,252 per ha in CF and SPNF, respectively. The net return over Cost D ₹4,026 per ha and ₹ 337 per ha in CF and SPNF, respectively.

Operational cost (Cost A), i.e., cash variable expenses and Average Total cost (Cost D), was highest in elephant foot yam among different crops grown on the farm. In elephant foot yam corm production, net return over Cost A and Cost D were highest.

Table 4.26: Different farm management costs and returns in major crops cultivated by sample elephant foot yam growers

(₹/ha)

Sr. No.	Particulars	Elephant foot yam		Elephant foot yam corms		Maize		Wheat	
		CF	SPNF	CF	SPNF	CF	SPNF	CF	SPNF
1	COST A	195947	194118	34560	35052	16064	15739	25711	18351
2	COST B	213432	211271	54032	53928	24045	23323	33692	25935
3	COST C	311585	317384	163635	168522	50495	63319	63045	70229
4	COST D	342744	349123	179999	185375	55544	69651	69349	77252
5	Gross returns	923177	915853	1031250	1087043	62875	70533	73375	77588
	Net returns								
i.	COST A	727230	721736	996690	1051991	46811	54794	47664	59237
ii.	COST B	709746	704583	977218	1033115	38830	47210	39683	51653
iii.	COST C	611592	598469	867615	918521	12380	7214	10330	7360
iv.	COST D	580433	566730	851251	901669	7331	882	4026	337

CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

4.10 Production and disposal of major crop produce on sample farm under different farm practices

The production and marketed surplus of different crops grown on the sampled farms have been presented in Table 4.27.

In CF, average production of elephant foot yam was found to be 59 quintals per farm, out of which 54.05 quintals was marketed surplus, accounting for 91.60 per cent of the total produce. 6.72 per cent produce was kept as planting material, the rest 1.68 per cent utilised for self-consumption/ gifts and loss at the farm. In SPNF, total produce was 48 quintals per farm, out of which 94.08 per cent, i.e., 45.16 quintals produce, was available as marketed surplus. About 3.92 per cent was kept as planting material, and the rest 2.00 per cent consisted of self-consumption, gifts, and loss at the farm.

In elephant foot yam corm production, CF had produced 7.21 quintal per farm, having a marketable surplus of 6.73 quintals per farm, accounting for 93.29 per cent of the total output. The produce kept as planting material was 6.71 per cent of the total produce. In SPNF, 90.74 per cent of 4.32 quintal per farm was marketed surplus. 9.26 per cent of the total produce was kept as planting material.

In CF Maize, 56.19 per cent i.e., 9.44 quintals per farm was available as marketable surplus out of total 16.80 quintals per farm. Another vital use of total production was as a gift or self-consumption, accounting for 41.86 per cent of the total produce (7.03 q/farm). Loss at farm and seed for planting material accounted for the remaining 1.95 per cent of the total produce. In SPNF, total produce was 10.25 quintal per farm, out of which 42.88 per cent was marketed surplus, i.e., 4.39 quintal per farm.

In CF Wheat, out of 22.75 quintal per farm, 49.95 per cent was marketed surplus. Another important use of total production was for self-consumption or gift accounting for 41.86 per cent of the total produce. Loss at farm and seed accounted for the remaining 1.95 per cent of the total produce. In SPNF, total produce was 14.49 quintal per farm, out of which 37.65 per cent was marketed surplus.

Table 4.27: Marketable and Marketed Surplus of major crops on sample farms under different crops

(q/farm)

Sr.No.	Particulars	Elephant foot yam		Elephant foot yam corms		Maize		Wheat	
		CF	SPNF	CF	SPNF	CF	SPNF	CF	SPNF
1	Production	59 (100.00)	48 (100.00)	7.21 (100.00)	4.32 (100.00)	16.80 (100.00)	10.25 (100.00)	22.75 (100.00)	14.49 (100.00)
2	Self-Consumption and gift	0.49 (0.82)	0.43 (0.89)	-	-	7.03 (41.86)	5.63 (54.89)	9.39 (41.26)	7.67 (52.91)
3	Kept as corm/seed	3.97 (6.72)	1.88 (3.92)	0.48 (6.71)	0.40 (9.26)	0.12 (0.69)	0.08 (0.75)	1.71 (7.53)	1.17 (8.09)
4	Marketable Surplus	54.55 (92.45)	45.69 (95.19)	6.73 (93.29)	3.92 (90.74)	9.65 (57.45)	4.55 (44.35)	11.65 (51.21)	5.65 (39.00)
5	Loss at farm	0.50 (0.85)	0.53 (1.10)	-	-	0.21 (1.26)	0.15 (1.48)	0.29 (1.25)	0.20 (1.35)
6	Marketed Surplus	54.05 (91.60)	45.16 (94.08)	6.73 (93.29)	3.92 (90.74)	9.44 (56.19)	4.39 (42.88)	11.36 (49.95)	5.46 (37.65)

Note: Figures in parentheses indicate percentages to the total in each category.
CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

4.11 Marketing channels for elephant foot yam in the study area

Table 4.28 shows that market channels for elephant foot yam disposal on total sample farms under different farming practices. In elephant foot yam marketing, there were four prominent marketing channels: Producer-Consumer Channel (Channel-I), Producer-Retailer-Consumer channel (Channel-II), Producer-Trader-Consumer (Channel-III), Producer-wholesaler-retailer-consumer (Channel-IV).

In Conventional Farming, total 1618.99 quintals elephant foot yam production was sold through four channels mentioned above. Channel-I, II, III and IV accounted for 8.10, 13.98, 31.85 and 46.70 per cent of the total CF produce respectively. Channel-I, II, and IV were opted by all 31 households for disposal of CF elephant foot yam produce. In SPNF, total produce was 1355 quintals of which 50.00 per cent was marketed through Channel-IV and remaining 6.71, 18.99 and 24.29 per cent elephant foot yam was disposed through Channel-I, II and III respectively. Like CF, Channel-I, II, and IV were opted by all 30 SPNF households for disposal of elephant foot yam produce. In elephant foot yam, Channel-IV emerged was the most important channel followed by Channel III for disposal of both CF and SPNF produce in the study area.

In elephant foot yam corm, three prominent marketing channels were there Producer-Consumer (Channel-I), Producer-Retailer-Consumer (Channel-II), Producer-Trader-Consumer (Channel-III). Total produce in conventional production was 209 quintals out of which 52.94, 5.74 and 41.32 per cent produce was marketed through Channel-I, II and III, respectively. In SPNF, total marketed EFY corm produce was 118 quintals out of which share of Channel-I, II and III was 47.80, 9.45 and 42.75 per cent, respectively. In Elephant foot yam corms, Channel-I followed by Channel-III was most important channel in study area as major proportion of total produce was marketed through these channels in CF and SPNF farms.

There were several agriculture markets located around the study area where produce was being sold by the farmers of the study area viz. Bilaspur, Swarghat, Solan, Ropar and Hoshiarpur. Farmers from the Bilaspur Sadar block sold their produce in the local market, Solan and Ropar. In the Jhanduta block, major marketing destinations were Swarghat, Hoshiarpur and Ropar APMC. Punjab Markets i.e., Hoshiarpur and Ropar offered better price for the EFY produce as compared to local market in Himachal Pradesh.

Table 4.28: Marketing channels followedfor disposal of elephant foot yam on sample farms

Sr. No.	Marketing Channel		Elephant foot yam				Elephant foot yam corms			
			Grower (No.)	Produce sold (q)	Grower (No.)	Produce sold (q)	Grower (No.)	Produce sold (q)	Grower (No.)	Produce sold (q)
			CF	CF	SPNF	SPNF	CF	CF	SPNF	SPNF
1	Channel-I	Producer-consumer	31 (100)	136 (8.10)	30 (100)	91 (6.71)	15 (48.39)	111 (52.94)	9 (30)	56 (47.80)
2	Channel-II	Producer-retailer-consumer	31 (100)	234 (13.98)	30 (100)	257 (18.99)	4 (12.90)	12 (5.74)	6 (20)	11 (9.45)
3	Channel-III	Producer-trader-consumer	16 (51.61)	534 (31.85)	17 (56.66)	329 (24.29)	15 (48.39)	86 (41.32)	12 (40)	51 (42.75)
4	Channel-IV	Producer-wholesaler-retailer-consumer	31 (100)	772 (46.70)	30 (100)	678 (50)	-	-	-	-
Total production			31 (100)	1676 (100)	30 (100)	1355 (100)	31 (100)	209 (100)	30 (100)	118 (100)

Note: Figures in parentheses indicate percentages to the total in each category.
CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

4.11.1 Marketing cost and margins of elephant yam and corms production through different channel

The foremost objective of an ideal marketing system is to ensure remunerative prices to producers and, at the same time, to provide commodities to the consumers at reasonable and affordable prices. Vegetable marketing requires specialized functions and handling. Therefore, different types of costs involved in marketing are unavoidable. Similarly, good margins to middlemen and other functionaries are also essential for survival and keeping themselves in business. But it has been observed that traders and middlemen keep exorbitantly high margins for themselves. Low cost of marketing margins and low-price spread is an indicator of high marketing efficiency. Besides, this costly packing, transportation etc. add to the cost of marketing, leaving minimal net price to the producers. The marketing costs and price spread for elephant foot yam and corms production in the study area, keeping this thing in view, were analyzed through important marketing channels prevalent in the study area.

Table 4.29: Marketing cost and margins in marketing of elephant foot yam and corms through, channel-I (producer to consumer)

(₹/q)

Sr. No.	Functionary	Elephant foot yam	Elephant foot yam corm
1	Net price received by the producer	2980 (99.33)	9965 (99.65)
2	Marketing cost incurred by producer	20	35
i.	Grading charges	-	15 (0.15)
ii.	Packaging charges	20 (0.67)	20 (0.20)
iii.	Transportation charges	-	-
iv.	Labor charges	-	-
3	Price paid by consumer	3000 (100)	10000 (100)

Note: Figures in parentheses indicate percentages to the total in each category.

Marketing of elephant foot yam through channel I (producer-consumer) led to quite attractive producer's share in the consumer's rupee. It was found to be 99.33 per cent amounting to ₹ 2980 per quintal (Table 4.29). The producer incurred a marketing cost of ₹ 20 per quintal, which is 0.67 per cent of the consumer's price. The price paid by consumers for a quintal was ₹

3000.In elephant foot yam corm marketing through Channel I, the consumer paid ₹ 10,000 per quintal, out of which 99.65 per cent was the producer's share. The producer incurred a marketing cost of ₹ 35 per quintal, which is 0.35 per cent of the consumer's price.

Table 4.30: Marketing cost and margins in marketing of elephant foot yam and corms through channel-II (producer –retailer-consumer)

(₹/q)

Sr. No.	Functionary	Elephant foot yam	Elephant foot yam corms
1	Net price received by the producer	2714 (77.55)	9904 (82.53)
2	Marketing cost incurred by producer	86	96
i.	Grading charges	-	-
ii.	Packaging charges	15 (0.43)	25 (0.21)
iii	Transportation charges	51 (1.45)	51 (0.42)
iv.	Loading/unloading Charges	20 (0.57)	20 (0.17)
3	Price paid by retailer	2800 (80)	10000 (83.33)
4	Margin of retailer	682 (19.49)	1970 (16.42)
5	Marketing cost incurred by retailer	18	30
i.	Loading/unloading Charges	-	-
ii.	Storage and losses	18 (0.51)	30 (0.25)
iii.	Transportation charges	-	-
6	Price paid by consumer	3500 (100)	12000 (100)

Note: Figures in parentheses indicate percentages to the total in each category.

In elephant foot yam marketing through channel-II (producer-retailer-consumer), the producer's share in the consumer's rupee was found to be ₹ 2,714 per quintal which is 77.55 per cent (Table 4.30). The producer incurred a marketing cost of ₹ 86 per quintal, which is 2.45 per cent of the consumer's price. The price paid by the retailer for the produce was ₹ 2,800 per quintal, and the margin of the retailer was ₹ 682 per quintal, which is 19.49 per cent of the

consumer's price. Marketing cost incurred by retailers was ₹ 18 per quintal, which is 0.51 per cent of the consumer's price. The price paid by the consumer was ₹ 3,500 per quintal.

In elephant foot yam corm marketing through channel-II (producer-retailer-consumer), the producer's share in the consumer's rupee was found to be 82.53 per cent (₹ 9,904/q). Marketing costs incurred by the producer were found to be ₹ 96 per quintal, which is 0.80 per cent of the consumer's price. The price paid by the retailer for the produce is ₹ 10,000 per quintal, and the trader's margin was ₹ 1,970 per quintal, which is 16.42 per cent of the consumer's price. The marketing cost incurred by the trader was₹ 30 per quintal, which is 0.25 per cent of the consumer's rupee. The price paid by the consumer for a quintal was ₹ 12,000.

Table 4.31: Marketing cost and margins in marketing of elephant foot yam and corms through, channel-III (producer -trader-consumer)

(₹/q)

Sr. No.	Functionary	Elephant foot yam	Elephant foot yam corms
1	Net price received by the producer	3485 (87.12)	9975 (87.13)
2	Marketing cost incurred by the producer	15	25
i.	Grading charges	-	-
ii.	Packaging charges	15 (0.38)	25 (0.38)
iii.	Transportation charges	-	-
iv.	Loading/unloading Charges	-	-
3	Price paid by trader	3500 (87.50)	10000 (83.33)
4	Margin of trader	370 (9.25)	1850 (15.41)
5	Marketing cost incurred by trader	130	150
i.	Loading/unloading Charges	20 (0.5)	20 (0.16)
ii.	Storage and losses	30 (0.75)	50 (0.41)
iii.	Transportation charges	80 (2)	80 (0.66)
iv.	Commission	-	-
6	Price paid by consumer	4000 (100)	12000 (100)

Note: Figures in parentheses indicates percentages to the total in each category.

In elephant foot yam marketing through channel-III (producer-trader-consumer), the producer's share in the consumer's rupee was 87.12 per cent (Table 4.31). Marketing costs incurred by the producer were found to be ₹ 15 per quintal, which is 0.38 per cent of the consumer's price. The price paid by the trader for the produce was ₹3500 per quintal, and the margin of the trader was ₹ 370 per quintal, which is 9.25 per cent of the consumer's price. The marketing cost incurred by the trader was ₹ 130 per quintal. The price paid by the consumer for a quintal was ₹ 4,000.

In elephant foot yam corm marketing through channel-III (producer-trader-consumer), the producer's share in the consumer's rupee was 87.13 per cent, which is ₹ 9,975 per quintal. Marketing costs incurred by the producer were found to be ₹ 25 per quintal, which is 0.38 per cent of the consumer's price. The price paid by the trader for the produce was ₹ 10,000 per quintal, and the trader's margin was ₹ 1,850 per quintal, which is 15.41 per cent of the consumer's price. The marketing cost incurred by the trader was ₹ 150 per quintal. The price paid by the consumer for a quintal corm was ₹ 12,000.

In disposal of elephant foot yam through channel-IV (producer-wholesaler-retailer-consumer), the producer’s share in the consumer’s rupee was found to be 74.32 per cent (Table 4.32). The producer incurred marketing cost of ₹ 155 per quintal. The price paid by the wholesaler for the produce was ₹ 3500/q, and the margin of wholesalers was ₹ 179 per quintal, which is 3.98 per cent of the consumer’s price. The marketing cost incurred by the wholesaler was ₹ 321 per quintal. The price paid by the retailer was ₹ 4,000 per quintal, and the margin of the retailer was ₹ 395 per quintal. The marketing cost incurred by the retailer was ₹ 105 per quintal. The price paid by the consumer for a quintal was ₹ 4,500.

Table 4.32: Marketing cost and margins in marketing of elephant foot yam and corms through, channel-IV (producer –wholesaler-retailer-consumer)

(₹/q)

Sr. No.	Functionary	Elephant Foot Yam
1	Net price received by the producer	3345 (74.32)
2	Marketing cost incurred by producer	155.48
i.	Grading charges	-
ii.	Packaging charges	17 (0.38)
iii.	Transportation charges	118 (2.63)
iv.	Loading/unloading Charges	20 (0.44)
3	Price paid by wholesaler	3500
4	Margin of wholesaler	179 (3.98)
5	Marketing cost incurred by wholesaler	321
i.	Loading/unloading Charges	-
ii.	Storage and Losses	21 (0.47)
iii.	Transportation charges	-
iv.	Commission/ market fee	300 (6.67)
6	Price paid by retailer	4000
7	Margin of retailer	395 (8.78)
8	Marketing cost incurred by retailer	105
i.	Loading/unloading Charges	20 (0.44)
ii.	Transportation charges	50 (1.11)
iii.	Losses and storage	35 (0.78)
9	Price paid by consumer	4500 (100)

Note: Figures in parentheses indicates percentages to the total in each category.

4.12 Problems and constraints in elephant foot yam cultivation

An opinion survey was performed to determine the issues that farmers encounter when growing elephant foot yam. The constraints encountered by the respondents were categorized into four categories, namely; input constraints, labor constraints, SPNF constraints, and others. The findings regarding these constraints were then classified into I, II, III, IV, and V categories, based on their ranking level. The results have been presented in Table 4.33.

Among problems related to the input constraint in CF, the timely supply of corms was absent and it emerged as a significant problem faced by the farmers with an average Garrett score of 45.39. In SPNF, untimely supply and non-availability of corms had an average Garrett score of 49.10 and 41.30 with Rank I and Rank II, respectively.

Major problem in elephant foot yam production under CF as well as SPNF was the crop damage by animals and it Ranked I among several problems with an average Garrett's score of 46.23 and 49.10, respectively. Other problems faced by the CF farmers were the weed infestation, absence of package of practices for elephant foot yam, unavailability of irrigation facility, diseases, and insect-pest attack with an average score of 46.17, 45.39, 45.10, 43.71, and 41.19, respectively and Rank II, III, IV, V and VI, respectively. In SPNF farming similar problems with almost same ranks existed. Other problems were regarding the package of practices for elephant foot yam, weed infestation, unavailability of irrigation facility, diseases, and insect-pest attack having average Garrett's score of 48.30, 45.70, 43.90, 43.00, and 40.50 with a rank of Rank II, III, IV, V and VI.

Table 4.33: Problem and constraints faced by sample elephant foot yam growers in production **(Garrett's Score)**

Sr. No.	Problems/Constraints	Conventional Farming			SPNF		
		Sum of score	Mean	Rank	Sum of score	Mean	Rank
A.	Input constraints						
i)	Non-availability of corms	-	-	-	1240	41.30	II
ii)	Supply of corms in time	1407	45.39	I	1474	49.10	I
B.	Production related						
i)	Irrigation facility not available	1398	45.10	IV	1318	43.90	IV
ii)	Problems regarding the package of practices for raising Elephant foot yam	1407	45.39	III	1448	48.30	II
iii)	Diseases	1355	43.71	V	1291	43.00	V
iv)	Insect pest	1277	41.19	VI	1214	40.50	VI
v)	Attack by animals	1433	46.23	I	1474	49.10	I
vi)	Weed Infestation	1426	46.17	II	1370	45.70	III

CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

4.13 Problems and constraints in marketing of elephant foot yam cultivation

Farmers were asked about various problems related to the marketing of elephant foot yam, and an opinion survey was conducted to identify the issues faced at various marketing steps in the different marketing channels. The constraints encountered by the respondents have been categorized into four categories, namely; Packaging/ binding material constraints, SPNF related constraints, and others. Garrett's score was used then to classify problems into ranks according to their score. The results are presented in Table 4.34.

In CF and SPNF, packaging problem had an average Garrett score of 41.19 and 46.31, respectively. In CF, high transportation charges were a significant problem, with an average Garrett score of 60.48. Other problems were non-availability of vehicle at the time and lack of vehicles were ranked II and III with a Garrett's score of 54.29 and 48.77, respectively. In SPNF,

main problems were high transportation charges, non-availability of vehicles in time. Problem of high transportation charges was Ranked I with an average Garrett's score of 79.00. Other problems included non-availability of vehicle in time and it ranked II with Garrett's score of 50.83.

In SPNF, the major problem was the absence of the remunerative rate for the product with Garrett's score of 50.55 and Rank I. Lack of sufficient demand for natural products and specialized market for natural farming produce were ranked II and III with Garrett's score of 45.67and 43.93, respectively.

Absence of local market for both type of EFY was a significant problem, having Rank I with an average Garrett's score of 54.61 and 52.60, for CF and SPNF, respectively. In CF, lack of proper market channel for elephant foot yam and lack of information related seed production were other problems having rank II and III, respectively. In SPNF, the same issues were existed in same sequence with an average score of 47.40 and 44.80, respectively. Kumar (2020) also reported problems like lack of govt. support, inadequate training facilities, lack of extension facilities, non availability of specialized market, no fair price in marketing of SPNF vegetable in Mandi District of HP.

Table 4.34: Problems faced by sample elephant foot yam growers during marketing

(Garrett's Score)

Sr. No.	Problems/Constraints	Conventional Farming			SPNF		
		Sum of score	Mean	Rank	Sum of score	Mean	Rank
A.	Packing/binding material						
i)	Shortage of packing/binding material	1277	41.19	I	1389	46.31	I
B.	Transportation						
i)	Lack of vehicles	1512	48.77	III	1519	50.63	III
ii)	Vehicle not available in time	1683	54.29	II	1525	50.83	II
iii)	High transportation charges	1875	60.48	I	2370	79.00	I
C.	SPNF Farming						
i)	Lack of market for natural farming produce	-	-	-	1318	43.93	III

ii)	Lack of high price premium for natural farming produces	-	-	-	1500	50.00	I
iii)	Lack of sufficient demand for natural farming products	-	-	-	630	45.67	II
D.	Others						
i)	Lack of proper market channel for EFY	1615	52.10	II	756	47.40	II
ii)	Market is very far from farm	1693	54.61	I	1578	52.60	I
iii)	Lack of information related to Seed Production	1095	35.32	III	1344	44.80	III

CF- Conventional Farming SPNF- Subhash Palekar Natural Farming

5. SUMMARY AND CONCLUSIONS

5.1 Introduction

Agriculture is the dominant sector of the Indian economy. Despite the focus on the manufacturing and service industry, agriculture is still the dominant sector in terms of gross domestic product (GDP) and as an employment source. The resilience of Indian agriculture sector can be seen from the fact that despite the COVID-19 pandemic, its performance in output was substantial and came up with a robust growth rate of 3.4 per cent 2020-21.However, agriculture is exposed to three of the greatest challenges of the 21st century – sustaining food and nutrition security, adaptation and mitigation of climate change and sustainable use of critical resources such as water, energy and land. The F.A.O has as recently (April, 2018) urged that all countries to move towards the adoption of Agro-ecology to meet the twin goals of global food security and conservation of the environment and Natural Farming principles are in sync with the principles of Agro-ecology.

Natural Farming is a holistic alternative to present high-cost chemical inputs-based agriculture and it synchronizeperfectly with the principles of Agro-ecology. It is altogether different from organic farming as it discourages externally sourced inputs and encourages indigenous cow dung-urine cultures. The Government of Himachal Pradesh (GoHP) has implemented a flagship programme *'Prakritik Kheti Khushhal Kisan Yojana'* (PK3Y) from 2018 to double farmers' income as envisioned by Sh. Narender Modi, Hon'ble Prime Minister of India. It aims to sustain farming of mountainous smallholders through adoption of Subhash Palekar Natural Farming (SPNF)/Zero Budget Natural Farming (ZBNF), which is an emerging agro-ecological practice that has spread in India, as a form of agricultural system focusing on transformation rather than management of an existing system.

Tuber crops are the third most important food crops, after cereals and legumes. Cassava, sweet potato, elephant foot yam, aroids, and a few other tuber crops are major tropical tuber crops. They can be produced with very low inputs and used as vegetables. They have high starch content and used for industrial purposes.Elephant foot yam (*Amorphophallus paeoniifolius***)** is a major tuber crop that may be found all throughout Asia. China, Bangladesh, India (including the

Andaman Islands), Sri Lanka, Lao PDR, Myanmar, Thailand, Viet Nam, Indonesia, Java, the smaller Sunda Islands, Sumatera, New Guinea, Borneo, Malaysia, the Philippines, northern Australia, Fiji, and Samoa. In India, it is mainly cultivated in Andhra Pradesh, West Bengal, Gujarat, Kerala, Tamil Nadu, Maharashtra, Uttar Pradesh, and Jharkhand etc. as an intercrop e.g., with banana and coconut. The elephant foot yam cultivation gained momentum in India after the introduction of a new variety Gajendra, a non-irritant smooth corm type variety. It is being cultivated on an area of 33,000 ha, with a production of 801,000 MT.

Himachal Pradesh is a hilly state, with more than 80 per cent of farmers having small and marginal landholdings with limited irrigation infrastructure. Monkey menace is also emerging as a big challenge and has forced many farmers to give up farming. Despite these bottlenecks, the government aims to double the farming income by the year 2022 without adversely impacting the state's ecology. Therefore, there is an urgent need to explore various cropping options to overcome these bottlenecks and ensure the sustainable agriculture growth, increased income levels and better employment avenues for the farmers and elephant foot yam is one such viable and remunerative cash crop.

The Bilaspur district of Himachal Pradesh has agriculture as its mainstay as 80 per cent of population depends on it (Anonymous, 2020b). The area under vegetables has grown significantly in the district which at present covers 3554 hectares having 94641 metric tonnes production (Anonymous, 2020c). Similarly, the area under elephant foot yam has also increased to 86 hectares with a production of 3698 metric tons in 2019-20(Anonymous, 2020d).The present study, therefore, was undertaken to examine the economics of elephant foot yam (*Amorphophallus paeoniifolius*) under natural and conventional cultivation in district Bilaspur (H.P.).

Objectives:

- To study the economics of Elephant foot yam under natural and conventional cultivation on different categories of farms.
- To analyze the marketing of Elephant foot yam in the study area.
- To examine the prospects of and constraints in the spread of Elephant foot yam crop in the state

5.2 Methodology

The study was conducted in the Bilaspur district of Himachal Pradesh. The area was purposively chosen as the cultivation of elephant foot yam is primarily concentrated in the district. Two stages random sampling technique was used in this study for the selection of the sample of farmers to collect primary data. Two blocks namely, Bilaspur Sadar and Jhanduta were selected purposely in consultation with the officials of the State Agricultural Department as these blocks had the maximum area under elephant yam crop. In the first stage, list of elephant foot yam growing villages were prepared and form the list so prepared total eight villages comprising four villages were selected randomly equally from selected blocks. In the second stage, the list of farmers growing elephant foot yam under conventional practices and SPNF were prepared. Total sample of 61 farmers comprising 31 using conventional farming practices and 30 using natural farming practices (SPNF) were selected randomly and through proportional allocation method. The current study is largely based on primary data collected through personal survey method on a pre-determined timetable. In agricultural year 2020-21, Simple tabular analysis using averages, ratios, and percentages has been extensively employed to fulfill the specific objectives to the study.

5.3 Major findings

- The average family size (4.65) was slightly higher in conventional farming (CF) practicing households as compared to SPNF (4.07). The proportion of nuclear families was higher (56.00 %) in SPNF than CF (45.00 %), and the joint family system was more prevalent in the CF households (55.00 %). Sex ratio in SPNF (53.49 %) was higher than Conventional Farming families (49.31%).

- The majority of heads of the elephant foot yam growers in CF (70.97 per cent) and SPNF (90 per cent) belong to 41-60 years age group. Similarly, maximum number of family members in both the categories was in the age group of 41-60. The dependency ratio of CF families (0.49) was higher than SPNF families (0.33).

- The Head of the families had completed education up to senior secondary and share of this education level in CF Families (54.84 %) and SPNF (53.33 %). The farmers practising SPNF had a slightly lower literacy rate than that of SNF. When family members were evaluated for education, Maximum members (31.25 %) in CF had completed secondary school. While in case of SPNF majority (28.68 %), had attained graduation level education in SPNF showing that they had better education status and capacity to make decisions for improving their farms.

- The occupational pattern of the working population indicated that agriculture was the primary employment of the heads of the families in both farming practices, with 80.65 per cent in CF and 76.67 per cent in SPNF.

- CF and SPNF producers' annual gross household income consisted was calculated to be Rs 2,60,327 and Rs 2,82,011, respectively. Farm income was the significant contributor to annual gross income in both the farming practices, i.e. 78.93 and 78.48 per cent under CF and SPNF, respectively.

- Livestock was one of the important conventional and farming and on an average the size of livestock unit was 8.26 animals on CF and 5.47 animals in SPNF farms category. The total investment on livestock was ₹ 1,78,710 in CF and ₹ 1,14,117 in SPNF in which the share of cow was highest on SPNF (20.12 %).

- Total worth of the farm buildings was ₹ 8,42,742 in CF and ₹ 8,30,700 in SPNF farms in which the share of residential building was more than 85 per cent in both categories of farm.

- The average investment in agricultural equipment and machinery on Conventional Farms was ₹56,146, whereas, in SPNF, it was ₹38,297.

- The average size of land holding under CF and SPNF was 1.46 and 0.82 ha, respectively. In CF, the average cultivated area was 1.12 ha, accounting for 76.44 per cent of total landholdings while in SPNF, the respective figures were 0.69 ha, and 85.00 per cent. Compared to SPNF (0.54 ha), CF (0.86 ha) had higher irrigated area.

- Cropping pattern on sample farms was dominated by maize and wheat under both categories of farms accounting 29.81 per cent in CF and 30.57 per cent in and 45.09 per CF and 46.55 per cent in SPNF, respectively.

- Among elephant foot yam had the highest productivity of 307.73 quintal per ha and 305.28 quintal per ha in CF and SPNF, respectively. In case of wheat it was 25 and 27 q per ha in CF and SPNF, respectively

- The input use pattern revealed that the seed rate for elephant foot yam in CF was 2437 kg per ha, against 2484 kg per ha in SPNF. In contrast, the seed required to produce elephant foot yam corms in CF was 222 kg per ha and 221.12 kg per ha in SPNF. The seed rate for maize was 17.28 kg per ha and 19.40 kg per ha in CF and SPNF, respectively. The wheat seed rate is 132.56 kg per ha in CF and 147.31 kg per ha in the case of SPNF. Organic manure, i.e., FYM, was being used by farmers under CF in all the crops. Fertilizers like urea in maize fields, and IFFCO mixture with along urea in wheat production was being used in CF. Mulching is the main component of SPNF practices for water management and weed control, hence it was used extensively under SPNF crops compared to CF farms.

- Labour use pattern for various crops grown on sample farms showed that total labour used in for elephant foot yam production were found to be 245 mand days in CF and 265 days in SPNF. Among the different cultivation operations, labor requirement was highest in the case of weeding, accounting for 53.24 per cent and 41.24 per cent of total labor in CF and SPNF, respectively. Harvesting was another labour intensive operation in elephant foot yam accounting for 24.13 per cent and 21.75 per cent in both CF and SPNF,

respectively. Weeding, being the highest labour utilizing component in corm production, accounted for 61.68 per cent in CF and 49.76 per cent in SPNF, followed by harvesting as the second-highest labour-intensive component, accounting for 21.93 per cent in CF and 19.71 per cent in SPNF. Total labor days requirement for elephant foot yam corm production were 274 man days and 286 man days in CF and SPNF, respectively.

- In maize, harvesting was highest labor consuming operation, accounting for 42.33 and 28.0 per cent of total labor days, i.e., 66 man days and 100 man days under CF and SPNF farming, respectively. In wheat, total labour requirement was74 man days for CF and 111man days for SPNF having harvesting as the significant component accounting for 39.39 per cent in CF and 26.19 per cent in SPNF of total labour usage.

- In elephant foot yam, total cost of cultivation was estimated at₹3, 11,585 per hectare in conventional farming whereas it was at ₹ 3, 17,384 in SPNF. Total variable cost in elephant foot yam production was ₹ 1,95,947 per hectare and Rs 1,94,118 per hectare in conventional practices and SPNF, respectively.Corms were the major which contribute to 87.05 per cent of total cost in the conventional practices and 89.57 per cent in SPNF. Elephant foot yam corm production has total cost of₹1, 63,635 per hectare in conventional farming and ₹ 1, 68,522 per hectare in SPNF, respectively. Total variable cost in elephant foot yam production was ₹ 1, 95,947 per hectare and ₹ 1,94,118 per hectare in conventional practices and SPNF having major component as corms which account to 64.13 per cent in the conventional practices and 63.08 per cent in SPNF.

- In elephant foot yam the gross return were valued at ₹ 9, 23,177 per hectare in conventional farming and ₹ 9, 15,853 per hectare in SPNF and return over total cost were at ₹ 6,11,592 per hectare and ₹ 5,98,469 per hectare in conventional practices and SPNF, respectively. In conventional farming practices, the total and variable cost of production about ₹ 1013 and ₹ 637/ quintals, respectively. The per quintal total cost of production was found to be marginally higher compared to CF.

- In elephant foot yam corm production the gross return was valued at ₹ 10,31,250 per hectare in conventional farming and ₹ 10,87,043per hectare in SPNF with net returns over total cost of ₹9,96,690per hectare and ₹10,51,991per hectare in conventional practices and SPNF, respectively. In conventional farming per quintal total cost of production was founded to be ₹ 1,587 per quintal, whereas, in SPNF, it was₹1,550 per quintal. The variable cost of production was ₹335 per quintal in conventional practices and ₹ 322 in SPNF.

- In CF, average production of elephant foot yam was found to be 59 quintals per farm, out of which 54.05 quintals was marketed surplus, accounting for 91.60 per cent of the total production, whereas, In SPNF, total production was 48 quintals per farm, out of which 94.08 per cent, i.e., 45.16 quintals, was available as marketed surplus. In elephant foot yam corm production, CF had the production of 7.21 quintal / farm, having a marketable surplus of 6.73 quintals / farm, accounting for 93.29 per cent of the total production. In SPNF, 90.74 per cent of 4.32 quintal per farm was marketed surplus. In CF Maize, 56.19 per cent i.e. 9.44 quintals / farm was available as marketable surplus out of total production of 16.80 quintals / farm. In SPNF, total produce was 10.25 quintal / farm, out of which 42.88 per cent was marketed surplus, i.e., 4.39 quintal per farm. In CF the total production of wheat was 22.75 quintal / farm, 49.95 per cent was marketed surplus. In SPNF, total produce was 14.49 quintal / farm, out of which 37.65 per cent was marketed surplus.

- In elephant foot yam, in channel-I (producer-consumer), the producer’s share in the consumer’s rupee was found to be 99.33 per cent (₹ 2980 / q) and price paid by consumer was ₹ 3000. In channel-II (producer-retailer-consumer), the producer’s share in the consumer’s rupee was found to be 77.55 per cent (₹ 2,714 /q) and price paid by consumer was ₹ 3,500. In channel-III (producer-trader-consumer), the producer's share in the consumer's rupee was 87.13 per cent, (₹ 3,485/ q) and price paid by the consumer for a quintal was ₹ 4,000. In channel-IV (producer-wholesaler-retailer-consumer), the producer’s share in the consumer’s rupee was found to be 74.32 per cent which is ₹3,345 / q and price paid by the consumer for a quintal was ₹ 4,500.

- In elephant foot yam corm production, in channel-I (producer-consumer), the consumer paid Rs 10,000 per quintal, out of which 99.65 per cent was the producer's share. In channel-II (producer-retailer-consumer), the producer's share in the consumer's rupee was found to be 82.53 per cent which is Rs 9,904 per quintal and the price paid by the consumer for a quintal was Rs 12,000.In elephant foot yam corm production, in the case of channel-III (producer-trader-consumer), the producer's share in the consumer's rupee was 87.13 per cent, which is Rs 9,975 per quintal and the price paid by the consumer for a quintal was Rs 12,000.

- The problems regarding the package of practices related to elephant foot yam production, attack by animals, intensive labor requirement in SPNF, high weed infestation in SPNF were the major problems faced by the farmers in production of elephant foot yam and other major crops.

- Lack of proper market channel, no premium rates for SPNF produce, market far from farm, lack of information related to seed production are some of the major problems faced by the farmers in the marketing of elephant foot yam and corm production.

5.4 Suggestions and policy implications

Bilaspur district in particular and Low and Mid Hill conditions in general has huge untapped potential for expansion of area and production of elephant foot yam crop. Based on the findings of the study, the following suggestions may be considered for commercial cultivation of elephant foot yam in the study area and state.

- New improved varieties of elephant foot yam like Gajendra and Sree Padma should be tested and introduced in the state as they have higher productivity and better taste.
- Besides this, local varieties of elephant foot yam are found to be more successful under SPNF practices. Therefore, Local varieties /land races of elephant foot yam should be screened by R&D organizations to develop improved varieties and seed. These varieties

should also be popularized among farmers to further increase productivity of elephant foot yam in the state.

- There should be provision of need based training to the farmers rgarding various technologies related to elephant foot yam corm production and preventive and control measures to manage the rotting of elephant foot yam corms should be imparted to the elephant foot yam producers through on field trainings.
- Natural farming of elephant foot yam is profitable as well as eco-friendly (no use of chemical fertilizers and pesticides), therefore, extension efforts should be focused on interested farmers by all govt. agencies to spread its cultivation through SPNF in others districts of state where elephant foot yam cultivation is feasible.
- Certification of the SPNF elephant foot yam produce should be done so that farmer can get remunerative prices for their chemical free produce.
- There are no organized markets outlets for natural farming produces in the state, farmers have to compulsorily sell their produce in the local/distant markets at ordinary prices. Hence, efforts should be made to establish an arrangement in regulated markets for exclusive marketing of natural farming elephant foot yam produce in Himachal Pradesh.
- Processing of EFY in various products can add value to this crop, thereby, increasing income of various stake holders besides creating employment opportunities. Therefore, various processing options need to be explored to achieve these benefits.

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APPENDICES

Appendix-I

FARMER'S SURVEY SCHEDULE

Code No._____

Department of Agricultural Economics, Extension Education &Rural Sociology

CSK HP Krishi Vishvavidyalaya, Palampur (H.P.) – 176062

Farmer's Survey Schedule

Title of research problem: Economics of Elephant foot yam (*Amorphophallus paeoniifolius*) under natural and conventional cultivation in District Bilaspur (H.P.)

Objectives:

- To study the economics of Elephant foot yam under natural and conventional cultivation on different categories of farms.
- To analyze the marketing of Elephant foot yam in study area.
- To examine the prospects of, and constraints in spread of Elephant foot yam crop in state.

1) Farmer/Respondent's information

Name	:	Contact No. (Mobile)	:
Village	:	Age (years)	:
Post office	:	Education	: I/P/M/H/S/D/G/PG
Block	:	Type of family	: Joint/Nuclear
Main occupation	:	Subsidiary occupation	:
Holder	: (Marginal/Small/Large)	Experience in EFY cultivation	:
Distance from market	:	Distance from Pacca road	:

2) Demographic information

S. No.	Relation with the respondent	Age(years)	Gender (M/F)	Education I/P/M/H/S/D/G/PG	Occupation		Approximate annual income (₹)	
					Main Occupation	Subsidiary Occupation	Main Occupation	Subsidiary Occupation
1								
2								

Where, I- Illiterate, P-Primary, M- Middle, H- High school, S- Senior secondary, D- Diploma- Graduation and PG- Post Graduation

3) Inventory and Land Utilization (Kanal/Bigha)

Sr. No.	Particulars	Area (Kanal/Bigha)			Source of irrigation
		IR	UIR	Total	
1.	Owned land				
2.	Leased-in land				
3.	Leased-out land				
4.	Total holding				
	(1+2-3)				
Land Utilization:					
1.	Cultivated land				
2.	Orchard land				
3.	Fallow land				
5.	Land under Misc. (trees/grasses/forest)				
6.	Permanent pastures				
7.	Any other				
	(grassland)				
8.	Total holding				

IR= Irrigated, UIR= Un-irrigated

Land rent: - (1) Leased in .....**Rs/ (*Kanal/Bigha*)**
(2) Leased out..... **Rs/ (*Kanal/Bigha*)**

4) Farm Buildings and Farm Asset Position

Sr. No.	Particulars	No.	Type of Building			Year of purchase/Construction	Present Value (Rs.)	Annual Repair (Rs.)	Source of Funds	Remark
			Katcha	Pucca	Mixed					
1	**Farm Buildings**									
	Residential Building									
	Cattle Shed									
	Store house									
	Vermicompost Shed									
2	**Major Farm Machinery**									
	Tractor									
	Chaff-cutter									
	Thresher									
	Sprayer									
	Power tiller									
3	**Minor Implements**									
	Plough (Wooden/Iron)									
	Spade/Belcha									
	Hoe									
	Rake									
	Sickle – Small									
	Sickle – Large									
	Axe									
	Planker									
	Kudali									
	Plastic pipe for irrigation									
	Water storage structure(If any)									
	Water Barrels (Plastic)									
	Fawara									
	Bamboo/Plastic baskets									

Note: PS- Personal savings, L- Loan from bank/ society/ friends/ relatives/ money lenders

5) Livestock Inventory

Sr. No.	Particulars	No.	Lactation (No.)	Milk (l per day)/ Eggs (No. per day)/ Wool (kg/yr)/Meat (kg)	Present value (Rs.)	Remarks
1	**Cow(Local)**	**Breed_____**				
	In milk					
	Dry					

2	**Cow (Improved)**	**Breed_____**				
	In milk					
	Dry					
3	**Buffalo**					
4	**Bullocks**					
5	**Heifer**					
	Cow					
	Buffalo					
6	**Calves**					
	Cow					
	Buffalo					
7	**Sheep**					
8	**Goat**					
9	**Other**					

6) Cropping pattern and production of crops

Sr. No.	**Crop**	**Area (*Karnal/Bigha*)**	**Variety**	**Main product**		**By-Product**		**Nature of cropping (SPNF/Chemical)**
				Qty(Q)	**Value(Rs.)**	**Qty (Q)**	**Value(Rs)**	
Kharif Season								
1	**Cereal Crops**							
	Maize							
	Paddy							
2	**Pulses**							
3	**Oilseeds**							
4	**Fodder**							
5	**Vegetables & spice crops**							
	Elephant foot yam							
	Tomato							
	Capsicum							

	Cucumber							
	Brinjal							
	Okra							
Rabi Season								
1	**Cereal Crops**							
	Wheat							
2	**Pulses**							
3	**Oilseeds**							
4	**Fodder**							
5	**Vegetables & spice crops**							
	Elephant foot yam							

7) Cost of Cultivation of Elephant Foot Yam

Classification: Natural/Conventional **Area: (kanal/bigha)** **Crop before EFY:**

Date of sowing: **Date of harvesting:** **Crop after EFY:**

Source of Corms

Input use and operation wise labour utilization

Sr.No.	**Particulars**	**Crop**					
		EFY					
		Quantity	**Value**	**Quantity**	**Value**	**Quantity**	**Value**
1	**Area(*kanal/Bigha*)**						
2	**Companion Crops**						
	Crop1						
	Crop2						
	Crop3						
3	**No. of Ploughing**						
	Tractor (hrs.)						
	Bullock (No. of BPD)						

4	**Type of varieties used**						
	Local						
	Hybrid						
5	**Seed rate /No. of corms**						
6	**FYM**						
7	**Natural farming input**						
8	**Mulching material**						
9	**Fertilizer**						
10	**Plant Protection/Chemicals**						
11	**Chemicals**						
12	**Micronutrients**						

Human labour inventory and utilization (man days)

Sr.No	Operations	EFY														
		Human Labour (Man Days)				Machine Power(hours)	Human Labour(Man Days)				Machine Power(hours)	Human Labour(Man Days)				Machine Power(hours)
		Hired		Family			Hired		Family			Hired		Family		
		M	F	M	F		M	F	M	F		M	F	M	F	
1	**Field Preparation**															
2	**Ploughing**															
3	**Preparation of ridges**															
4	**Planting of corms**															

5	**Spacing**	P-P														
		R-R														
6	**Pit Size**															
7	**Disposal of FYM**															
8	**Intercultural Operations**															
	Weeding															
	Earthing up															
	Mulching															
	Waapsa															
9	**Preparation of Jeevamrita**															
10	**Preparation of Beejamrita**															
11	**Application of manure**															
12	**Application of Jeevamrita**															
13	**Application of Beejamrita**															
14	**Application of pesticide**															
15	**Application of fertilizers**															
16	**Spraying/Dusting operation**															
17	**Harvesting**															
18	**Cleaning/Grading**															

Note:

Wage rate/day: **Male(Rs/day)** **Female(Rs/day)**
Land Rent: **Land revenue**
Bullock Labor/Day: **Machine Rate / hour:**

8) Companion Crops

Sr.No.	**Crop Production**		**Main Crops Under SPNF**				
			EFY				
1	**Companion Crop1**						
	Variety						
	Yield						
2	**Companion Crop2**						
	Variety						
	Yield						
Crop1	**Main Product**	Qty					
		Value					

	By-Product	Qty					
		Value					
Crop2	**Main Product**	Qty					
		Value					
	By-Product	Qty					
		Value					

9) Opinion about the expenses in Agriculture

Natural Farming	**Conventional Farming**
Very High	Very High
Moderate	Moderate
Less	Less

10) Marketing channels for EFY

Sr. No.	**Channel**	**Quantity sold(q)**
1	Producer-consumer	
2	Producer-retailer-consumer	
3	Producer- trader-consumer	
4	Producer-processor-consumer	
5	Producer-wholesaler-consumer	
6	Producer-wholesaler-retailer–consumer	

11) Production and marketing of EFY

Sr.No.	**Particulars**	**Name of variety**	
1	Total production (qtl)		
2	Self-consumption (kg)		
3	Kept as planting material		
4	Losses		
5	Qty. sold		
6	Selling Price (Rs. /qtl.)		
7	Place (Market) where sold		
8	Agency		
9	Distance of the market from the farm		
10	Transportation charges		
	Tractor		
	Truck		
	Other (specify)		

11	Loading and unloading charges (Rs/qtl.)		
12	Commission charges (Rs. /qtl.)		
13	Weighing charges (Rs. /qtl.)		
14	Market fees		
	Other charges, if any		
15	Price received by grower (₹/qtl)		

12) Problems faced by farmers and their responses

Sr. No.	Problems	Response		Rank					Suggestion
		Yes	No	I	II	III	IV	V	
A.	**Seed**								
i)	Non-availability of planting material/corms								
ii)	Supply of planting material/corms in time								
B.	**Labour**								
i)	Shortage of skilled labour								
ii)	High wage rate								
iii)	Non-availability of labour at peak operation time								
iv)	Intensive labour requirement in SPNF Farming								
C.	**SPNF Farming**								
i)	Lack of sufficient technical information about natural farming								
ii)	Lack of availability of resources for natural farming								
iii)	Low productivity of natural farming compared to conventional farming								
iv)	High pest/diseases attack in natural farming								
v)	High weed infestation in natural farming								
D.	**Fertilizers**								

i)	High transportation cost								
ii)	Desired brand not available								
iii)	Fertilizers not available in time								
E.	**Plant protection**								
i)	High prices of chemicals								
ii)	Chemicals not available in time								
iii)	Sale of spurious chemicals								
F.	**Other problems**								
i)	Non-availability of healthy plant material/corms								
ii)	Scarcity of FYM								
iii)	Lack of perennial supply of irrigation								
iv)	Irrigation facility not available								
v)	Problems regarding the package of practices for raising Elephant foot yam								
vi)	Diseases								
vii)	Insect pest								
viii)	Climatic condition								
ix)	Stray animals								
x)	Lack of technology etc.								
xi)	Less availability of Extension services								

Note: I-very high, II-high, III-medium, IV-low, V-very low

13) Problems faced by farmers at various stages of marketing and their responses

Sr. No.	**Problems**	**Response**		**Rank**					**Suggestion**
		Yes	**No**	**I**	**II**	**III**	**IV**	**V**	
A.	**Packaging**								
i)	Shortage of skilled labour								

ii)	High wage rate								
iii)	Non-availability of labour at peak operation time								
B.	**Packing/binding material**								
i)	Shortage of packing/binding material								
ii)	Higher prices								
iii)	Not available in time								
iv)	Not available at the desired place								
C.	**Transportatio**n								
i)	Lack of vehicles								
ii)	Vehicle not available in time								
iii)	Village not linked with metalled roads								
iv)	High transportation charges								
D.	**Market intelligence**								
i)	Late information								
ii)	Information available limited								
iii)	Limited to market only								
iv)	Inadequate information								
v)	Misleading information								
vi)	Prices information not available in time								
E.	**Malpractices**								
i)	Deduct more charges								
ii)	Multiplicity of charges								
iii)	Deduct undue charges								
iv)	Delayed payment								
v)	Quote lower than the actual price								
F.	**SPNF Farming**								
i)	Lack of market for natural farming produce								
ii)	Lack of high price premium for natural farming produces								
iii)	Lack of sufficient demand for natural farming products								
G.	**Others**								

Note: I-very high, II-high, III-medium, IV-low, V-very low

Appendix-III

List of sample farmers in the study area

Sr. No.	Name of respondent	Village	Block	Contact no.
1	Aanant Ram	Karot	Sadar	8628852851
2	Baldev Raj	Karot	Sadar	9857102891
3	RamPal	Karot	Sadar	9817012310
4	Prem Lal	Karot	Sadar	8894261551
5	Vinod Kumar	Karot	Sadar	9817184644
6	Jagdish Singh	Karot	Sadar	9418045624
7	Sanjeev Kumar	Karot	Sadar	8219875802
8	Amar Nath	Karot	Sadar	9817843373
9	Rampal	Karot	Sadar	8988237720
10	Jaidev Singh	Makri	Sadar	8219723021
11	Chaman Lal	Makri	Sadar	9857573000
12	Naresh Kumar	Makri	Sadar	8219073950
13	Roop Singh	Makri	Sadar	7018014830
14	Pyare Lal	Makri	Sadar	8219174401
15	Jeet Ram	Makri	Sadar	8219659359
16	Shashi Pal	Makri	Sadar	9625533586
17	Suresh Kumar	Makri	Sadar	9805274800
18	Gagan	Sayar Dobha	Sadar	8219733214
19	Chhota Ram	Sayar Dobha	Sadar	7876850170
20	Kuldeep Gautam	Sayar Dobha	Sadar	8351800023
21	Amarnath	Sayar Dobha	Sadar	9625610022
22	Prem Lal	Sayar Dobha	Sadar	8219633753
23	Pawan Kumar	Sayar Dobha	Sadar	8580467491
24	Kashmiri Lal	Sayar Dobha	Sadar	9736473905

25	Bhupendra Singh	Sayar Dobha	Sadar	8544794769
26	Chait Ram	Sayar Dobha	Sadar	9817164731
27	Nandlal	Kuddi	Sadar	8219641017
28	Ram Das	Kuddi	Sadar	8211941017
29	Roop Lal	Kuddi	Sadar	8219462483
30	Birender Kumar	Kuddi	Sadar	7018290079
31	Bipin Bihari	Kuddi	Sadar	7018301460
32	Susheel Kumar	Kuddi	Sadar	8219700015
33	Randheer Thakur	Kuddi	Sadar	8219439972
34	Roop Lal	Kuddi	Sadar	
35	Bharat Bhusan	Fagog	Jhanduta	8679214000
36	Aanad Kumar	Fagog	Jhanduta	9817160113
37	Rajpal Singh	Fagog	Jhanduta	9816545162
38	Bihari Lal	Fagog	Jhanduta	9817097694
39	Ram Lal	Fagog	Jhanduta	9882723796
40	Narender Kumar	Fagog	Jhanduta	8544793415
41	Narotm	Fagog	Jhanduta	9816366248
42	Suresh Kumar	Fagog	Jhanduta	8580933307
43	Ramkishan	Thuran	Jhanduta	
44	Krishan Kumar	Thuran	Jhanduta	9418686103
45	Baldev	Thuran	Jhanduta	9459675561
46	Natwarlal	Thuran	Jhanduta	9459675570
47	Surender Singh Chandel	Gherwin	Jhanduta	9817698205
48	Vinod Chandel	Gherwin	Jhanduta	8219270875
49	Shakti Singh	Gherwin	Jhanduta	7018050104
50	Sita Ram	Samleta	Jhanduta	8091635357
51	Ramanand	Samleta	Jhanduta	9817192717

52	Tota Ram	Samleta	Jhanduta	Tota Ram
53	Nandu Ram	Samleta	Jhanduta	Nandu Ram
54	Sukha Ram	Samleta	Jhanduta	Sukha Ram
55	Dev Sharan	Samleta	Jhanduta	7807484910
56	Ram Singh	Samleta	Jhanduta	8988803577
57	Dila Ram	Samleta	Jhanduta	9418849092
58	Dhani Ram	Samleta	Jhanduta	9625869769
59	Sita Ram	Samleta	Jhanduta	8219399205
60	Gagan Pal	Samleta	Jhanduta	8219733214
61	Sharwan Kumar	Samleta	Jhanduta	8219399205

Brief Bio-data of student

Name	:	Prashant Thakur
Father's Name	:	Sh. Rajesh Thakur
Mother's Name	:	Smt. Anjna Thakur
Date of Birth	:	1st July, 1996
Permanent Address	:	Narain Enterprises, Near New Bus Stand, Ghumarwin, Distt. Bilaspur, H.P., 174021.
Contact Number	:	8628880490

Academic Qualification: (starting with 10th class)

Qualification	Year	School/Board/University	Marks (%)	Major Subjects
10th	2012	DAV Public School (CBSE)	92.00%	English, Maths, Hindi, Social science, Science.
10+2	2014	DAV Public School (CBSE)	85.00%	Physics, Chemistry, Mathematics, English Physical education.
B.Sc. (Agriculture)	2018	CSK HPKV, Palampur	67.90%	All Agriculture subjects
M.Sc. (Agriculture)	2020	CSK HPKV, Palampur	74.00%	Agricultural Economics and Vegetable Science
Thesis Title in M.Sc.		Economics of Elephant foot yam (*Amorphophallus paeoniifolius*) under natural and conventional cultivation in District Bilaspur (H.P.)		
Fellowships/Scholarships/Gold Medals/Awards:		-		
Research papers		-		
Others				