

A STUDY ON PERCEPTION OF PRECISION FARMING BY THE FARMERS

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INTRODUCTION

India's population is projected to be around 1,350 million by 2020 AD which requires food grain production of 343 million tonnes (Harshal *et al.*, 2006). Considering the current food grain production levels, India needs to raise food grain growth by not less than 4.00 per cent per year. On the other hand the available per capita cultivable land has declined from 0.48 ha (1951) to 0.14 ha (2005) and by 2050 it may further decline to 0.07 ha that is for every 14 persons only one ha land will be available to produce all essential items like food, fiber, fuel, fodder, fruits *etc.* (Harshal *et al.*, 2006). As the availability of land has decreased, application of fertilizers and pesticides become necessary to increase the food production. The major effect is that our agriculture has become chemicalized. In this situation, it is essential to develop eco-friendly technologies for maintaining sustainable crop productivity. Since long, it has been recognized that crops and soils are not uniform within a given field. Increasing agricultural productivity perhaps remains the single most important determinant of economic growth and poverty reduction, and hence provides the key to millennium development goal. Improvements in productivity come from adoption of new technologies and increase in production efficiency.

'Precision farming' or Precision agriculture aims at increasing productivity, decreasing production costs and minimizing the environmental impact of farming. The management of in-field variability in soil fertility and crop conditions for improving crop production and minimizing the environmental impact is the crux of precision farming. New technologies, such as Global Positioning Systems (GPS), sensors, satellites or aerial images, and Geographical Information Systems (GIS) are utilized to assess and analyse variations in agricultural production.

Precision agriculture or precision farming as it is sometimes called, a management strategy that employs detailed and site specific information to precisely manage production inputs. Precision farming is a form of agriculture where site specific management practices are adopted giving due considerations to the spatial variability of land in order to maximize crop production and minimize the environmental damage (Harshal *et al.*, 2006). Precision farming requires information about soil properties, landscape, elevation and how these characteristics affects the plant growth and crop progress throughout the field season. Precision agriculture is a comprehensive approach to farm management, and has the goals and outcomes of increased profitability and sustainability, improved product quality, effective and efficient pest management, energy, water and soil conservation, surface and ground water protection (Grisso *et al.*, 2002), reduced costs, erosion, and environmental impact of chemicals, and the better management of large farms (Blackmore *et al.*, 1994).

Precision farming is generally defined as information and technology based farm management system to identify, analyze and manage variability within fields for optimum profitability, sustainability and protection of the land resources. In this method of farming, new information technologies can be used to make better decisions about many aspects of crop production. Precision farming involves looking to increased efficiencies that can be realized by understanding and dealing with the natural variability found within a field. The goal is not to obtain the same yield everywhere, but rather to manage and distribute inputs on site specific bases to maximize long term cost benefit ratio. Applying the same inputs across the entire field may no longer be the best choice. Precision farming is helping many farmers worldwide to maximize the effectiveness of the crop inputs.

Precision farming distinguishes itself from traditional agriculture by its level of management where instead of managing the whole fields as a single unit, management is customized for small areas within fields. The increase level of management emphasizes the need for sound agronomic practices.

The more suitable definition for precision farming in the context of Indian farming scenario could be precise application of agriculture inputs based on soil, weather and crop requirements to maximize sustainable productivity, quality and profitability. Today because of increasing input costs and no remunerative prices for commodities, farmers are looking for new ways to increase efficiency and cut costs. Precision farming or precision agriculture is about doing the right thing, in the right place, in the right way and at the right time. Managing crop production inputs such as water, seed, fertilizer etc to increase yield, quality, profit, reduce waste and becomes eco-friendly. The intent of precision farming is to match agricultural inputs and practices as per crop and agro-climatic conditions to improve the accuracy of their applications

Precision farming aims at optimizing profitability and protecting environment through efficient use of inputs based on temporal and spatial variability of soils and crops. Both sensor based and

satellite image based technologies have been developed and are being promoted in the developed world. The economic analyses of the adoption of precision farming have indicated marginal profitability to already existing Best Management Practices (BMPs) and higher productivity levels. In view of the wide gap between the potential and actual yield levels in the developing world necessitates for promoting precision farming to achieve the intended benefits.

Present Scenario

Although precision farming is very much talked about in developed countries, it is still at a very nascent stage in developing countries, including India Space Application Center, ISRO, in collaboration with Central Potato Research Institute, Shimla, has initiated a study on exploring the role of remote sensing for precision farming. The study on precision agriculture has already been initiated in India, in many research institutes. Space Application Center (ISRO), Ahmedabad has started experiment in the Central Potato Research Station at Jalahandhar, Punjab to study the role of remote sensing in mapping the variability with respect to space and time. M. S. Swaminathan Research Foundation, Chennai, in collaboration with NABARD, has adopted a village in Dindigul district of Tamil Nadu for variable rate input application. Indian Agricultural Research Institute has drawn up a plan to do precision farming experiments in the institutes' farm. Project Directorate for Cropping Systems Research (PDCSR), Modipuram and Meerut (UP) in collaboration with Central Institute of Agricultural Engineering (CIAE), Bhopal also initiated variable rate input application in different cropping systems. In the ensuing few years precision farming may help the Indian farmers to harvest the fruits of frontier technologies without compromising the quality of land.

Precision farming technology would be a viable alternate to improve profitability and productivity. Precision agriculture gives farmers the ability to use crop inputs more effectively including fertilizer, pesticides and irrigation water. More effective use of inputs means greater crop yield and quality, without polluting the environment. A clear perception of various aspects of precision farming by the farmers is key to its success

Keeping the above facts in mind, the present study was designed to understand how farmers are perceived Precision farming practices. The following specific objectives were formulated for the detailed study.

1. To study the precision farming technique as perceived by farmers.
2. To analyze relationship between perception of precision farming technique and socio economic characters of farmers.
3. To study the impact of precision farming technique on productivity and income of farmers.
4. To identify the constraints faced in adoption of precision farming practices.

Scope of the study

The findings on perception of precision farming practices by farmers would help us to have better understanding about their perception level and the pattern of adoption of recommended precision farming technologies. The study also focuses on the impact of precision farming technologies through which one can understand the actual benefits derived by the farming out of the precision farming technologies. Further the constraints faced in adoption of precision farming technologies would also be studied thoroughly this will help us to work out suitable extension strategies. The findings of the study will help the research system to reorient research programmes to refine the technologies in accordance with the location specific issues of the farmers.

Limitation of the study

The study has tried to over come all the limitations within its control. This study is a student research work, and hence there is a limitation of finance, time and other resources which rendered it difficult to take up the study. The present study was conducted in few selected villages of Bagalkot, Belgaum, Dharwad and Haveri district. Therefore, the findings of the study cannot be generalized to other areas and other population of precision farming practicing farmers as a whole. As the study used the *Ex-post-facto* design all the disadvantages and shortcoming that are associated with design itself set a limitation for the study. Even though, the investigator had taken utmost care while collecting the data, possibility of leaving the room for some errors or limitations can not be ruled out.

REVIEW OF LITERATURE

A brief review of literature is an integral part of any investigation as it not only gives an idea on the work done in the past, but also provides the basis for interpretation and discussion of the findings. The present study is regarding perception of precision farming by the farmers. Efforts are made to review the available literature having direct or indirect bearing on present study. For the sake of convenience, the available related reviews are presented under the following headings.

- 2.1 Meaning of perception
- 2.2 Profile of the farmers
- 2.3 Perception of precision farming technique
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2.1 Meaning of perception

Intodia *et al.* (1993) defined perception as a process whereby the individual organizes and makes sense of his sensory experience.

Van den Ben and Hawkins (1996) defined perception as the process by which we perceive information or stimuli from our environment and transform it into psychological awareness.

Pujari (2002) defined perception as response to stimulus. It is an active process, whereby sensory reactions are related to relevant past experience of an individual when confronted with stimulus and most structured and meaningful picture is printed in the mind which is finally perceived as the object.

Khan (2004) defined perception as all the processes involved in creating meaningful patterns out of a jumble of sensory impressions fall under the general category of perception. It is an individual's awareness aspect of behavior, for which it is the way each person processes the raw data he or she receives from the environment into meaningful patterns.

Dahama and Bhatnagar (2005) defined perception as a meaningful sensation. It is the process of filling in, enabling us to interpret a series of fragments as a whole when sensory data are incomplete. It enables us to identify objects and situations in our environment.

Dash and Tripathy (2005) defined perception as interpretation of sensory experience in the light of past knowledge, information and experience. Perception is a process in which meaning is attached to sensory experience. It is an integrated process in which attention, sensation and attachment of meaning are involved in an unbroken sequence.

Singh *et al.* (2006) defined perception as the act of interpreting a stimulus registered in the brain by one or more sense of mechanism. Perception refers to the way the world looks, sounds, feels, tastes, *etc.* It is immediately experienced by a person. Perception can be defined in terms of process giving rise to our immediate experience to the world.

Rajamanickam (2008) stated that perception is a process of integration and interpretation of what the mind receives. Perception involves responding to the world through the senses. It is not a total response to everything that we see the outside world with our senses. Some of the responses are specific and serve some purpose on a particular occasion.

By going through the above definitions in simple terms it could be said that the perception is a mental picture of an individual created through the stimuli by relating with the past experiences.

2.2 Profile of the farmers

2.2.1 Age

Batte *et al.* (2003) in their study on adoption and use of Precision farming Technologies: a survey of central Ohio farmers reported that the average age of precision farming farmers were 54.70 years, about 3.50 per cent of the farmers were under 35 years of age and 18 per cent were over 65 years.

Flora (2007) in a study on sustainable water management through drip irrigation in Maduri district - an explorative study indicated that nearly 50.00 per cent adopters belonged to old age category, which was higher than the non-adopters (26.60%) of drip irrigation. There were 41.70 per cent of adopters who belonged to middle age category whereas 63.40 per cent non-adopters were belonged to the middle age category. Five per cent of adopters belonged to young age categories that were less than the non-adopters (10.00%).

Sudha (2008) in her study on prospects of precision farming in Dharmapuri district - a multidimensional analysis indicated that 52.50 per cent of the precision farming farmers were found in old age category, followed by 33.30 per cent in middle age category and only 14.20 per cent in young age category.

Satish (2010) in his study on farmers perceptions, preferences and utilization of SRI and traditional paddy straw for livestock indicated that majority (60.83%) of the respondents were middle aged followed by old aged (20.83%). The young age group constituted 18.33 per cent of the respondents.

Rakesh (2010) conducted study on precision farming in sugarcane - a diagnostic study revealed that majority precision farming sugarcane farmers (48.00%) were found in middle age category, followed by 35.30 per cent in the old age category and only 16.70 per cent in young category.

Priya (2011) conducted a research on comparative study on precision and conventional methods of onion cultivation in Theni district of Tamil Nadu reported that nearly half (46.67%) of the onion growers of precision farming were found to be middle aged, followed by 30.00 per cent in old aged and the remaining were in young aged category (23.33%). With regard to the onion growers of conventional method of farming, 48.33 per cent were old aged followed by 35.00 per cent middle aged and the rest of the 26.67 per cent were young aged.

Huded (2013) in his study on perceived attributes of IPM technologies as perceived by Bt cotton growers revealed, that majority (57.33%) of the Bt cotton farmers were middle aged followed by old (39.33%) and young (3.33%) age.

It was reviewed by researchers that most of the farmers, who belong to middle age group.

2.2.2 Education level

Batte *et al.* (2003) interpreted that as high as 40.40 per cent of precision farming farmers had high school degree, 13.00 per cent had less than a high school education and 37.00 per cent had some college education or college degree and 9.60 per cent had post graduation education or degree.

Rajeshkanna (2006) in his study on evaluation of market-led-horticulture under Tamil Nadu precision farming project revealed that most (93.00%) of the precision farming farmers of Dharmapuri district had education of middle school and upwards. In Krishnagiri district more than three-fourth (77.00%) of the farmers had middle school level of education and upwards.

Prakash (2008) conducted a study on farmers awareness and preference towards organized vegetable retailing firms reported that 58.00 per cent of the precision farming farmers belonged to the high school level education followed by collegiate (18.00%), middle school (15.00%), primary school (9.00%) and none of them were illiterate.

Sudha (2008) reported that 52.00 per cent of precision farming farmers were educated up to secondary level followed by collegiate education (17.50%) and primary school education (11.00%). She also observed that 4.10 per cent of farmers were functionally literate followed by illiterate (2.00%).

Sangeetha (2009) conducted a study on factors influencing in adoption of precision farming technologies in tomato cultivation observed that 90.00 per cent of the precision farmers were literates and 10.00 per cent were illiterate. The farmers under primary to middle education were about 50.90 per cent, whereas only 32.74 per cent of the farmers were with a secondary to collegiate education.

Senthilkumar (2009) in his study on drip irrigation economic and market potential in Coimbatore district indicated that majority of the drip irrigation farmers had primary education (41.00%) followed by middle school education (22.00%). Functionally literate were accounted to 16.00 per cent, followed by higher education namely secondary (11.00%) and collegiate education (6.00%)

was found among one-fifth of the farmers. Illiterates were constituted a very meagre percentage (4.00%).

Satish (2010) revealed that equal per cent (29.17%) of respondents studied up to middle and high school. One fifth (20.80%) of the respondents studied up to primary school followed by pre-university (15.83%) and graduate level (1.7%). The illiterate respondents constituted 3.33 per cent.

Rakesh (2010) stated that majority of precision farming sugarcane farmers (38.00%) were educated up to secondary level followed by functionally literates (18.00%) and middle education (16.00%). An equal percentage of farmers were (12.00%) come under primary and collegiate level. Only 4.00 per cent of the farmers were found to be illiterate.

Priya (2011) revealed that around two-fifth (41.67%) of precision farming onion growers had middle education, followed by secondary education (26.67%), functionally literate (15.00%) and primary education (10.00%). With regard to the conventional method of onion growers 50.00 per cent had middle school education, followed by primary education (18.33%) and secondary education (16.67%).

Huded (2013) revealed that 26.67 per cent of the farmers studied up to high school, while 24.00 per cent of the farmers studied up to middle school and 18.00 per cent of them were illiterates. More than ten per cent of the farmers were studied up to PUC (13.33%) and primary school (10.67%). Only 7.33 per cent of the farmers had education up to graduation.

A summary of above literature revealed that most of the farmers had education up to high school.

2.2.3 Family size

Rao (2000) conducted a study on sustainability of Rice farming and attitude of farmers towards sustainable agriculture in north coastal zone of Andhra Pradesh. The reported that the family size of marginal farmers was largest with an average of 6.93 members and for small farmers it was smallest (5.25 members).

Raghunandan (2004) based on his study on knowledge and adoption level of soil and water conservation practices by farmers in northern Karnataka reported that majority of the respondents belong to medium sized families (62.85%), followed by big families (25%) and small families (13.75%).

Charan (2005) conducted a study on profile of Sujala Watershed Project beneficiary farmers in Dharwad district revealed that majority (56.00%) of families had members in family ranging from 5 to 8. While, 13.33 per cent and 30.67 per cent of families had members ranging upto 5 and above 8, respectively.

Satish (2010) found that 53.33 per cent of the respondents were belonged to big family size while 46.67 per cent of them belonged to small family size.

It could be inferred from the above literature that majority of the respondents belonged to medium size family.

2.2.4 Land holding

Shashidhara (2003) in a study on socio-economic profile of drip irrigation farmers in Shimoga and Davanagere districts of Karnataka state revealed that comparatively more number of farmers (46.67%) belonged to semi-medium category followed by medium (32.22%) and small land holding category (18.89%).

Raghunandan (2004) in his study on knowledge and adoption level of soil and water conservation practices by farmers in northern Karnataka revealed that, majority of the respondents belonged to medium land holding (48.75%) followed by semi-medium land holding category (30.00%).

Satish (2010) found that 50.84 per cent of the respondents were medium land holders, 28.33 per cent of them were big, 20.00 per cent of them were small land holders and very negligible per cent 0.83 of them were marginal landholders.

Priya (2011) stated that little more than two -fifth (41.67%) of the onion growers of precision farming were big farmers, followed by medium farmers (40.00%). The rest of the respondents were small famers (18.33%). With regard to the onion growers of conventional method of farming one-third

(33.33%) of the respondents were small farmers, followed by medium (31.67%) farmers. The rest of the respondents were big framers (18.33%) and marginal farmers (16.67%).

Huded (2013) revealed that 56.67 per cent of farmers belong to semi-medium land holding category followed by medium farmers (29.33%), small farmers (11.33%), marginal farmers (2.00%) and big (0.67%) farmers categories

From the above studies, it could be concluded that, majority of farmers had medium land holding.

2.2.5 Annual income

Sangeetha (2009) inferred that 50.91 per cent of the precision farmers had high level of income, followed by 31.82 per cent with medium level and 17.27 per cent with low level of income.

Senthilkumar (2009) indicated that majority (58.00%) of the drip irrigation farmers were found to be distributed in low level of income (< Rs. 50,000). Nearly one-third (32.00%) of the farmers annual income was up to Rs. 50, 000 and exactly one-tenth (10.00%) of the farmers had high annual income of above fifty thousand.

Rakesh (2010) found that majority of the precision farming sugarcane farmers (60.00%) come under high income category followed by medium (32.00%) and low (6.67%) categories.

Satish (2010) found that 36.66 per cent of respondents belonged to high income group followed by medium (31.66%), semi medium (27.5%) income groups and 4.16 per cent of them were in low income group.

Priya (2011) stated that nearly three-fifth (61.67%) of the respondents of precision farming had high level of income, followed by medium (36.67%) and low (1.66%) levels. With respect to respondents of conventional method of farming in onion cultivation, more than half (58.34%) of them had low income, followed by medium (38.33%) and high income (3.33%).

Huded (2013) found that 60.66 per cent of the Bt cotton growers had medium annual income. While 34.66 per cent and 4.66 per cent of Bt cotton growers belonged to high and low annual income category, respectively.

It could be inferred from the above literature that majority of the farmers were high income category.

2.2.6 Mass media participation

Basavaraddi (1999) revealed that a large number of participants (66.66%) had medium level of mass media participation followed by higher (30.00%) and (3.33%) lower level of participation.

Gattu (2006) conducted a study on production constraints of cotton cultivation in Karimnagar district of Andhra Pradesh revealed that majority (44.17%) of the respondents belonged to medium mass media participation category. Whereas, 29.16 per cent and 26.67 per cent of farmers belonged to high and low mass media participation category, respectively.

Sudhir (2009) conducted a study on knowledge and adoption of *Bacillus Thuringiensis* (Bt) cotton practices followed by farmers in Haveri district, Karnataka state reported that, more than one third proportion of the Bt cotton growers (38.75%) had medium mass media participation and nearly equal percentage of them (32.50%) belonged to low mass media participation category. Whereas, 28.75 per cent of them belonged to high mass media participation category.

Manjunath (2011) conducted a study on knowledge and adoption of Bt cotton recommended production practices followed by farmers in Raichur district of Karnataka revealed that radio was possessed by 18.33 per cent of the respondents, whereas 4.17 and 7.50 per cent of them regularly listened to agricultural and general programmes while 5.83 and 9.17 per cent of respondents occasionally listened to agricultural and general programmes, respectively. Television was possessed by 81.67 per cent of the respondents. In which 16.67 and 30.83 per cent of them regularly viewed, and 29.17 and 52.50 per cent of respondents occasionally viewed agricultural and general programmes, respectively. While news paper subscription of the respondents recorded 20.83 per cent, of which 7.50 and 10.83 per cent of respondents were regular readers, while 6.67 and 8.33 of respondents were occasional readers of agricultural and general news, respectively.

Taskeen (2012) conducted a study on mechanization needs of sugarcane growers. The data pertinent to mass media utilization revealed that 77.33 per cent of the sugarcane growers did not read newspaper to know general or agricultural news whereas 20.00 per cent of the sugarcane growers read general news regularly and 19.33 per cent of them read agricultural news regularly. As regards to the farm magazines an overwhelming majority of the sugarcane growers (93.33% and 92.00%) never read general articles and agricultural articles, respectively. As high as 61.30 per cent of the sugarcane growers occasionally viewed general programmes in television followed by 34.67 per cent who viewed general programmes regularly in television.

It could be inferred from above studies that, majority of farmers were having medium level of mass media participation.

2.2.7 Extension contact

Anand (1992) conducted a study on farmers perception of drip irrigation efficiency in grapes revealed that 40.00 per cent of the drip irrigation adopters were in medium category on extension contact, followed by low (35.00%) and high (25.00%) extension contact categories.

Belligeri (1996) conducted a study on knowledge, adoption and perception of usefulness of agro forestry practices by the farmers of Hanagal taluk of Dharwad and revealed that majority of the respondents were contacted the Agriculture Assistants (85.00%), followed by Agricultural Assistant Officer (64.00%), Subject Matter Specialists (41.00%), Assistant Director of Agriculture (18.00%), Forest Motivator (26.60%) and Range Forest Officers (14.00%).

Basavaraddi (1999) conducted study on participation, perception and attitude of participants towards selected bio energy technologies of ASTRA in Karnataka revealed that large majority of participants (90.00%) had low level of extension contact, followed by medium (6.66%) and high (3.33%) of extension contact.

Gattu (2006) conducted a study on production constraints of cotton cultivation in Karimnagar district of Andhra Pradesh revealed that majority (80.83%) of respondents had medium extension contact followed by high (11.67%) and low (7.50%) extension contact.

Rakesh (2010) found that majority of the precision farming sugarcane farmers 58.00 per cent of the farmers had medium level of extension contact, followed by 28.70 per cent with high level and 13.30 per cent with low level of extension contact.

Satish (2010) revealed that more than half of the respondents (65.84%) belonged to medium extension contact group followed by high (19.16%) and low (15%) extension contact.

Jyoti (2012) in her study on farm mechanization expectations of cotton growers reported that nearly half of the cotton growers (48.13%) belonged to medium extension contact category, followed by high (30.00%) and low (21.88%) extension contact categories, respectively.

Taskeen (2012) conducted a study on mechanization needs of sugarcane growers. It was evident from the data that 49.33 per cent of the farmers had low extension contact, while 28.00 per cent of the farmers had high extension contact. Medium extension contact was observed in 22.67 per cent of growers.

Huded (2013) in his study reported that 43.33 per cent of the Bt cotton growers had medium level of extension contact, while 33.33 and 23.34 per cent of them had high and low levels of extension contact, respectively.

The above reviews revealed the fact that most of the respondents belonged to low level of extension contact followed by medium and high level of extension contact.

2.2.8 Innovative proneness

Anand (1992) conducted a study on farmers perception of drip irrigation efficiency in grapes revealed that 40.00 per cent of the drip irrigation adopters were medium on innovative proneness, whereas, 30.00 per cent each were grouped under low and high innovative proneness categories.

Shashidhara (2003) in his study on socio-economic profile of drip irrigation farmers in Shimoga and Davangere district of Karnataka found out that, 47.50 per cent medium innovative proneness category followed by low (31.66%) and high (20.83%) innovative proneness categories, respectively.

Bandgar *et al.* (2004) in their study on adoption of university recommended cotton technologies and the constraints faced by the farmers in Buldhana district of Maharashtra reported that majority of cotton growers (50.00%) were distributed in low innovative proneness category, followed by 30.00 and 20.00 per cent of them distributed in the medium and high categories, respectively.

Taskeen (2012) conducted a study on mechanization needs of sugarcane growers indicated that 43.33 per cent of the sugarcane growers belonged to medium category of innovative proneness followed by 30.67 per cent in 'low' and 26.00 per cent in 'high' categories, respectively.

Huded (2013) in his study revealed that, 40.00 per cent of the respondents belonged to medium innovative proneness category followed by low (35.33%) and high (24.66%) categories.

The above reviews revealed that most of the farmers fall under the medium group/category in their innovativeness. Here, innovativeness is an important part in the farming which leads to improvement in their present farming system.

2.2.9 Material possession

Meti (1990) conducted a study on attitude of farmers towards farm implements and their extent of use observed that 46 per cent of farmers of Dharwad district possessed sprayer and only very less number of respondents (less than 10.00%) possessed tractor.

Shyam (1992) revealed that a tractor, a cultivator, a seed drill and at least one pumpset were owned by more than 92.00 per cent of the farmers and crop thresher by 72.50 per cent of the farmers in selected district of Maharashtra.

Naik (1993) conducted a study on awareness, attitude and use pattern of seed supplying agencies by the farmers of Dharwad district found that 37 per cent of farmers possessed sprayers. Tractor and power tiller were possessed by 8 and 6 per cent of farmers of Dharwad district.

Prasad (2002) in his study on general knowledge of rural youth about improved agriculture, their attitude and participation in farm activities found that majority (62.67%) of the families of rural youth possessed bullock pairs, 24.67 per cent were possessing tractors and 9.33 per cent of the families of rural youth were possessing pump sets. Only 4 per cent were possessing threshers.

Shashi (2004) in his study on farm mechanization in sugarcane, cotton and groundnut crop- a analysis reported that 37.50 per cent of the cotton growers belonged to high level of material possession, followed by medium (32.50%) and low (30.00%), respectively.

Manjunath (2010) revealed that high majority (96.00%) of the respondents were possessed television, whereas vehicles, sprayers and dusters were possessed by 90.85 and 89.71 per cent of the respondents, respectively. Agricultural implements and radio were possessed by 64.00 per cent and 48.00 per cent of the respondents, respectively. Only 19.42 per cent of them were having bullock cart.

Priya (2011) revealed that more than half (51.67%) of the precision farming onion growers had high level of material possession, followed by medium (30.00%) and low (18.33%) levels. With regard to respondents of conventional method of farming in onion cultivation, more than half (55.00%) of them had medium level of material possession, followed by low (25.00%) and high (20.00%) levels.

Shambulingappa (2011) in his study on impact of Sujala Watershed Development programme in Dharwad district of Karnataka revealed that majority of the beneficiary farmers possessed wooden plough (74.17%), followed by seed drill (72.50%) and television (62.50%). Whereas, less per cent of beneficiaries possessed tractor (21.67%) and gohar gas plant (11.67%). On the other hand majority of non-beneficiary farmers possessed wooden plough (70.00%) followed by television (50.00%) and iron plough (46.70%). However, meagre per cent of non-beneficiaries possessed tractor (20.00%), whereas, only 3.30 per cent of them were having gohar gas plant.

Jyoti (2012) in her study on farm mechanization expectations of cotton growers revealed that 45.00 per cent of the cotton growers belonged to medium level category of material possession, followed by high level (31.25%) and low level (23.75%) categories of material possession.

From the above studies, it could be concluded that majority of the respondents had possess improved agricultural implements which are very much needed to their farming system (bullock cart, iron plough, sprayer, seed drill, harrows). Tractors and powers tillers were possessed by small per cent of the respondents

2.2.10 Crop productivity

Chandregowda and Jayaramaiah (1990) conducted a study on impact of watershed development programme on socio-economic status, land productivity, annual income of small and marginal farmers perceived that, due to increase in land productivity, the yields of Groundnut increased by 3.32 q/ac and 2.25 q/ac and in case of Ragi increased by 3.09 q/ac and 2.14 q/ac in the fields of small and marginal farmers respectively.

Singh (1990) conducted study a on rainfed agro-technology on watershed basis – a case study in his study conducted in Uttar Pradesh reported that the productivity increased by 21.4 per cent (pigeonpea) and 24.58 per cent (wheat) in about five years. The increases in productivity in other prime crops were mustard (23.9%), groundnut (22.5%), pearl millet (22.0%), black gram (17.0%), lentil (11.7%), grain (10.7%) and pea (7.5%), respectively.

Singh *et al.* (1995) in the study on watershed approach in improving the socioeconomic status of tribal area reported that, after implementation of project increased in land productivity. The watershed management programme has not only increased the crops yield but also developed fodder resources in the area. The productivity of maize, paddy, Jowar, black gram and wheat has increased by about 2.15, 2.16, 1.79, 3.62 and 2.07 times, respectively.

Verma *et al.* (2004) in the study on National Watershed Development programme revealed that the average yields per hectare of soybean, maize, wheat and potato were 15.66, 14.59, 23.47, and 213.45 quintals, respectively in NWDPR area as compared to 10.54, 9.48, 14.76, and 153.34 quintals, respectively in non-NWDPR area.

Gurumukhi and Sumit (2005) found that farmers were very much pleased with the productivity of sorghum level which excelled in tune of 3120 to 3450 kg/ha as compared to 1416 kg/ha of the average.

Dhyani *et al.* (2006) in their study on impact of watershed development and land use dynamics on agricultural productivity and also socio-economic status of farmers in central Himalayas indicated that the after implementation of the project significantly increased the yield of the crops by 21 per cent in potato at Mohnagad to 126 per cent in wheat at Khootgad. The total food grain production increased by 135 per cent in Mohnagad and 41.40 per cent in Khootgad.

Savita (2008) conducted a study on impact of community based tank management project on socio economic status of beneficiary farmers in Bidar district, Karnataka reported that difference in crop productivity in the pre and post project period, in case of sugarcane increased from 35 tonnes/acre to 40 tonnes/acre rising by 5 tonnes/acre. Similarly, in case of red gram increased from 3.5 q/acre to 6.0 q/acre rising by 2.5 q/acre and jowar increasing from 8 q/acre to 13 q/acre rising by 5 q/acre.

Sabi (2012) conducted a study on technology gap of wheat growers in Karnataka observed that the average rainfed yield of wheat in research area were found to be 4.5 q/ha, whereas the average irrigated wheat yield were found to be 9.78 q/ha.

Anil (2013) in his study on resource use and their contribution to livelihood of farm families revealed that the average yield of maize of 61.00 per cent of the farmers were found to be 13.70 q/acre, whereas the average *rabi* sorghum yield of 70.00 per cent of the farmers were found to be 4.57q/acre and average yield of pigeonpea of 83.33 per cent of the farmers were found to be 3.00 q/acre.

2.3 Perception of precision farming technique

Mankar *et al.* (1998) conducted a study on attributes of cotton variety AKH-84635 influencing its adoption. The study revealed that majority of respondents perceived the relative advantages of cotton variety such as low expenditure of sowing (82.00%) and low seed cost (79.00%) as very important. Further majority of respondents perceived cotton variety AKH-84635 was compatible with previous varieties (89.00%), try on small scale visible (80.00%), opportunity to observe on others field (86.00%) and no complicatedness (56.00%) as very important.

Jayakumar and Vasantakumar (1999) conducted study on perception of farmers towards package of practices for groundnut cultivation. The study revealed that groundnut cultivation technologies such as, ploughing the field for three to four times, applying 3 kg of enriched FYM or 5 tons of FYM/ ac in rainfed conditions and applying gypsum as basal and on 45th day after sowing were

perceived as useful by cent per cent of the farmers. Technologies like seed rate/ ac (99.00%) and spacing of 30 X 10 cm (84.00%) were perceived as useful by large majority of the farmers.

Man (2000) in his study of comparison of productivity level under conventional whole field farming and precision farming technology reported that Precision farming practices can not only improve the productivity of production, *i.e.*, nitrogen use efficiency, but can also help to build up nitrogen residual in the soil at the end of cotton growing season and can aid in improving the distribution of nitrogen residual levels across locations in the field.

Napier *et al.* (2000) found that farmers who perceived that they would receive returns on conservation investments and that conservation information was important in farm management decision-making were more likely to adopt precision agriculture. The farmers' perceptions of their ability to use precision agriculture were not a significant factor in the intention to adopt precision agriculture.

Maohua (2001) emphasized on the main ideas of precision agriculture as the understanding of spatial variability of soil properties, crop status and yield within a field, identifying the reasons for yield variability, making farming prescription and crop production management decisions based on variability and knowledge, implementing site-specific field management operations, evaluating the efficiency of treatment and accumulating spatial resource information for further management decision making.

Roberts *et al.* (2001) reported that twenty- three per cent (23.00%) of respondents had used at least one precision farming technology. The most common technologies used in cotton production were grid and management zone soil sampling, variable rate lime application, plant tissue testing, soil survey maps, and variable rate phosphorous and potassium application.

Pattanayak and Mercer (2002) reported that a higher per cent of farmers in Philippines perceived that agro-forestry will contribute to improvement and increase in thickness of top soil (87.00%), improvement in fertility (27.00%) and improvement in colour of soil (26.00%).

Adrian *et al.* (2005) reported in their investigations into the perception and attitudinal characteristics of farmers who plan to adopt these technologies that Attitudes of confidence toward using the precision agriculture technologies, perceptions of net benefit, farm size and farmer educational levels positively influenced the intention to adopt precision agriculture technologies. The perception of usefulness positively influenced perception of net benefit.

Adrian *et al.* (2005) reported that farmers' confidence in using precision agriculture affected the intention to adopt of precision agriculture technologies. They also found that the farmers' perceptions of net benefit affected the intention to use precision agriculture technologies. The perceptions of ease of use were not a significant factor affecting the intention to adopt precision agriculture.

Chandrashekar *et al.* (2005) conducted study on farmers perception towards innovation characters of GPU-28 Ragi variety and neem seed kernel extract (NSKE) spray in cabbage. The study revealed that majority of farmers were under high perception that growing GPU-28 ragi variety was a relatively advantageous (58.84%), less complexity (78.20%), compatible (73.68%), trailable (75.00%) and observable (56.25%) technology. Further majority of the farmers perceived that practicing NSKE spray in cabbage was relatively advantageous (50.00%), less complexity (73.68%), compatible (68.35%), trailable (72.20%) and observable (50.00%) technology.

Anne (2006) conducted a study on factors influencing adoption and use of precision agriculture and he revealed that 62.83 per cent of farmers have the knowledge of use of yield monitor in the precision farming system followed auto guidance (60.54%), GIS (57.85%), grid sampling (55.17%) and remote sensing (54.40).

Vasantha and Buchareddy (2006) conducted study on perception on attributes of IPM technologies by cotton farmers in Guntur district. The results revealed that majority of farmers perceived the relative advantages of IPM technologies in terms of initial cost as expensive. net profit as meager, consistency of profits as irregular, time taking and derive multiple benefits. Regarding complexity, majority of farmers perceived that IPM practices are feasible, non acceptable, unnecessary, they have no social recognition and are dependent. Further, majority of farmers perceived that the IPM technologies had cognitive complexity, they are adoptable, resource complexity is scarce technologies are reversible and consumes labour with respect to practicability of

IPM technologies, majority of farmers perceived that IPM technologies are demonstrable, communicable, reliable and visible.

Mansur *et al.* (2007) in a study on farmers perception about contour bunding at Dharwad. The study revealed that majority of respondents perceived preservation soil erosion (71.70%) and conservation of moisture (65.00%) were the main purpose of construction of contour bunds. The results further indicated that nearly fifty per cent of the respondents perceived that prevention of gully erosion and prevention of water and soil losses were main purpose of contour bunds. The other purposes of the contour bunds as perceived by the respondents were save soil fertility of top soil (21.70%), demarcation of field boundary (18.30%), growing fodder (16.70%) and planting trees (13.30%).

Ravi *et al.* (2007) conducted a study on farmer's perception and adoption pattern of soil and water conservation measures at Nalgonda district of Andhra Pradesh. It was observed that cent per cent of farmers had perception of in-situ conservation practices like summer tillage and field bunding across the slope, followed by ploughing across the slope (90.00%), vegetating the bunds (60.00%) and land leveling (50.00%). The conservation furrows (26.70%) and contour bunds (13.30%) were the least perceived aspects of soil and water conservation measures. Further the perception of Ex-situ conservation practices showed that a higher per cent had the perception of stone check (96.70%), followed by waste weir (93.30%), farm pond (66.70%), percolation pond (60.00%) and gabion structure (10.00%).

Sangeetha (2009) in her study on factors influencing in adoption of precision farming technologies in tomato cultivation inferred that majority of tomato farmers (81.82%) had medium to high level of knowledge on tomato cultivation under precision farming. About 18.18 per cent of the respondents had low level of knowledge on tomato cultivation under precision farming.

Daniel Mooney (2010) were surveyed regarding their attitude towards use of precision farming technologies and found that grid and zone soil sampling were the two most widely used information-gathering technologies being used by southern cotton farmers (46.00%). Yield monitors with GPS, soil survey maps, and aerial photography were the next most commonly used information gathering technologies (15.00% to 20.00%). Least used by adopters were yield monitoring without a GPS, satellite imagery, handheld GPS/PDA, COTMAN plant mapping, digitized mapping, and electrical conductivity (less than 10.00%).

Kale and Priti (2010) conducted a study on utility perception of soyabean growers about recommended cultivation technologies revealed that, majority of farmers (88.00%) perceived that sowing time was very useful, followed by FYM application (80.00%), harrowing (74.00%) and ploughing (72.67%), whereas 56.00 per cent, 52.00 per cent and 46.67 per cent of farmers perceived that plant protection, weeding and spacing were useful, respectively. Further majority of farmers (76.66%) perceived that use of micronutrients was not useful, followed by recommended sowing depth (13.33%), recommended fungicides (12.00%), spacing (10.64%), recommended fungicides for seed treatment (10.00%), while use of biofertilizers and chemical fertilizers through urea and super phosphate was perceived as not useful by each 7.33 per cent of the soybean growers.

Rakesh (2010) in his study on precision farming in sugarcane - a diagnostic study found that majority of the precision farming sugarcane farmers (48.00%) had high level of knowledge followed by medium (36.70%) and low (14.70%) level of knowledge.

Subhash and Singh (2010) in their study on precision farming for energy conservation and sustainable agriculture reported that a survey in Denmark, UK and UAS conducted with farmers who adopted precision agriculture shows that the farmers in general are optimistic.

Sudheendra and Jagadeesha (2010) conducted a study on perception about organic farming by contact farmers reported that, equal percentage (40.00%) of the respondents perceived organic farming as non use of chemicals of any type in production and organic farming means use of locally available eco-friendly material in farm production. Only twelve per cent of respondents perceived that organic farming was preparation of compost and vermicompost and using them in farm production. Organic farming was non use of hybrids and judicious use of water in farm production was perceived by eight per cent of respondents

Karthik and Manjunath (2011) in their study on attributes of hybrid seed production technologies as perceived by farmers. The study revealed that majority of the farmers perceived relative advantage of hybrid seed production technology such as paddy is a high yield potential verity (90.00%), consumption of hybrid paddy does not cause any health hazards (75.00%) and hybrid

paddy is superior to other variety (65.00%). The results also revealed that majority of the farmers perceived compatibility attributes of hybrid paddy seed production technology such as hybrid paddy seed production is easy as that of any other hybrid crops (100.00%), hybrid paddy seed production does not require additional implements (85.00 %) and hybrid paddy fits well into the cultural aspects in a social system (75.00%). The results also revealed that majority of the farmers perceived complexity attributes of hybrid paddy seed production technology such as knowing the quality of seed in hybrid paddy is difficult (100.00%) and that the maintenance of plant population is difficult in hybrid paddy compare to normal variety (85.00%). The results also revealed that majority of the farmers perceived observability attributes of hybrid paddy seed production technology such as the good growth of hybrid paddy crop in any season or in any month will give visual impact to others (100.00%) and hybrid paddy responds to different production inputs and can be observed clearly at different stages of the crop (90.00%). Cent per cent of the hybrid paddy seed growers perceived that growing of hybrid paddy seed production can be tried in a limited area in any given situation.

Krishna *et al.* (2011) study to understand why farmers do not adopt seemingly profitable precision farming technology. They observed that Farmers provided cost, time constraint, satisfaction with the current practice and other as reasons for not adopting precision farming technology. Results from a multinomial logit regression model indicated that manure application on field, more formal education, larger farm size, participation in conservation easement or agricultural easement generally decreases the probability of non-adoption of precision agriculture in cotton production.

Paxton *et al.* (2011) in their study on factors affecting the intensity of precision agriculture technologies adopted by cotton farmers given special attention to the role of spatial yield variability on the number of precision farming technologies adopted, using a count data estimation procedure and farm-level data. The report indicates that farmers with more within field yield variability adopted a higher number of precision agriculture technologies. Younger and better educated producers and the number of precision agriculture technologies used were significantly correlated. Also, farmers using computers for management decisions also adopted a higher number of precision agriculture technologies.

Ramesh and Santha (2011) conducted a study on attributes of sugarcane technologies as perceived by the farmers of quasi-government extension services. The study revealed that majority of the respondents of quasi-government extension services had perceived low level of relative advantage, low level of compatibility, low level of complexity, low level of observability and low level of trialability of sugarcane technologies. Further the study also revealed that majority of respondents of private extension services perceived high level of relative advantage, high level of compatibility, medium level of complexity, high level of observability and high level of trialability of sugarcane technologies

Savitha *et al.* (2011) conducted the study on perception of attributes of organic farming by the farmers of Andhra Pradesh indicated that majority of the organic farmers with respect to relative advantage perceived that the initial cost (75.00%), net profitability (65.00%) and consistency of profits (65.00%) of organic farming as high but as a time taking process (65.00%). Further compatibility of organic farming was found that, to be situationally (50.00%), culturally (55%) and relationally (100.00%) compatible and is having cognitive (58.3%), application (63.3%) and resource complexity (51.60%). Further, it was also observed that majority of the organic farmers felt it as practicable, sustainable (91.60%), results are certain (91.60%) but not observable (51.60%) and is having low perceived risk (56.60%).

Dantoni *et al.* (2012) investigates farmers' perception of precision agriculture and how those perceptions impact adoption of the autosteer GPS guidance system. Autosteer adoption was found to be significant and positively related to the perceived future importance of precision agriculture as well as farmers' ranking of input cost savings relative to other attributes of the autosteer GPS technology. Additionally, results show that the attributes of the cotton picker are also important factors in adoption of auto steer GPS technology.

Pandit *et al.* (2012) reported that formal education, farm size, and number of precision farming meeting attend by farmers have positive effect on adoption of PF technologies as well as probability of adopting precision farming technologies for profit reasons increases with spatial yield variability.

Rathakrishnan (2012) conducted study on drip irrigation- a water wise approach revealed that with respect to relative advantage, 70.34 per cent of adopters and 16.63 per cent of non adopters perceived that efficient use of water is possible with drip irrigation technology and water saving was

perceived by 90.00 per cent of adopters and 61.66 per cent of non adopters. Whereas in case of compatibility 80.00 per cent adopters and 13.33 per cent non adopters perceived as suitability of drip to all types of soil and 68.33 per cent of adopters and 11.66 per cent of non adopters perceived as suitable to all type of water. While, with respect to simplicity, 53.33 per cent and 18.33 per cent of adopters and non adopters perceived as spare parts are readily available, respectively. The drip technology was amenable for trial in small scale as opined by 40.00 per cent adopters and 13.33 per cent of non adopters. Further increase in the quality of produce was observed by 31.60 per cent of adopters and 11.66 per cent non adopters and crop maturity advanced was perceived by 23.33 per cent adopters and 13.00 per cent non adopters.

Thangaraja *et al.* (2012) conducted study on perception on critical technology adopted by vegetable growers under precision farming - an overview. The study revealed majority of the farmers 'highly preferred' that to use of recommended hybrid (71.11%), raising seedlings in community nursery (51.11%) and adoption of drip irrigation system (71.11%). Whereas, 62.22 per cent and 41.11 per cent of farmers felt that nutrification and micro nutrient application were very simple in precision farming system. Further the study revealed that technology like seed treatment with bio fertilizer and fungicides adoption were expressed as 'somewhat difficult to practice' (43.33%).

Rathod *et al.* (2013) studied impact of front line demonstration on adoption of seed treatment in soybean. The studied revealed that majority of the farmers said that seed treatment in soybean was highly advantageous, highly compatible, low complex and high observability.

2.4 Relationship of independent variables with farmers perception of crops/crop technology

Independent variable	Dependent variable	Respondents	Nature of relationship
Age			
Arulraj (1995)	Perception of early plating in sugarcane	Sugarcane growers	Non significant
Ramesh (2011)	Attributes of sugarcane technology	Sugarcane growers	Non significant
Priya (2011)	Precision and Conventional methods onion cultivation	Precision farmers	Non significant
		Conventional farmers	Non significant
Huded (2013)	Perceived attributes of IPM technologies	Bt cotton growers	Non significant
Education level			
Mankar (1998)	Attributes of cotton variety	Cotton growers	Non significant
Karthik (2011)	Attributes of hybrid seed production technologies	Paddy growers	Positive Significant
Priya (2011)	Precision and Conventional methods onion cultivation	Precision farmers	Positive Significant
		Conventional farmers	Positive Significant
Huded (2013)	Perceived attributes of IPM technologies	Bt cotton growers	Positive Significant
Family size			
Jayakumar (1999)	Perception of package of practices	Groundnut growers	Positive Significant
Land holding			

Jayakumar (1999)	Perception of package of practices	Groundnut growers	Positive Significant
Ramesh (2011)	Attributes of sugarcane technology	Sugarcane growers	Non significant.
Huded (2013)	Perceived attributes of IPM technologies	Bt cotton growers	Non significant.
Annual income			
Ramesh (2011)	Attributes of sugarcane technology	Sugarcane growers	Non significant
Priya (2011)	Precision and Conventional methods onion cultivation	Precision farmers	Non significant
		Conventional farmers	Non significant
Huded (2013)	Perceived attributes of IPM technologies	Bt cotton growers	Positive Significant
Mass media participation			
Karthik (2011)	Attributes of hybrid seed production technologies	Paddy growers	Positive Significant
Ramesh (2011)	Attributes of sugarcane technology	Sugarcane growers	Non significant
Huded (2013)	Perceived attributes of IPM technologies	Bt cotton growers	Positive Significant
Extension contact			
Ramesh (2011)	Attributes of sugarcane technology	Sugarcane growers	Non significant
Karthik (2011)	Attributes of hybrid seed production technologies	Paddy growers	Positive Significant
Priya (2011)	Precision and Conventional methods onion cultivation	Precision farmers and	Positive Significant
		Conventional farmers	Positive Significant
Huded (2013)	Perceived attributes of IPM technologies	Bt cotton growers	Positive Significant
Innovative proneness			
Ramesh (2011)	Attributes of sugarcane technology	Sugarcane growers	Positive Significant
Huded (2013)	Perceived attributes of IPM technologies	Bt cotton growers	Positive Significant
Material possession			
Jayakumar (1999)	Perception of package of practices	Groundnut growers	Positive Significant
Priya (2011)	Precision and Conventional methods onion cultivation	Precision farmers	Non significant
		Conventional farmers	Non significant
Crop productivity			
Jayakumar (1999)	Perception of package of practices	Groundnut growers	Positive Significant

2.5 Impact of precision farming technique on productivity and income of farmers

Sisodia (1992) evaluated the impact of Warabandi programme on land use, cropping pattern, cropping intensity and yield levels of principal crops in two selected districts of Madhya Pradesh during 1982-83 to 1986-87. As a result of introduction of the programme, irrigation ratio had increased from 40.19 per cent in 1981-82 (before Warabandi) to 87.39 per cent in 1986-87. The intensity of cropping showed a modest increase from 104.75 per cent in 1981-82 to 108.93 per cent in 1986-87. After enforcing Warabandi, *kharif* crops as a proportion of net area sown rose to 10.32 per cent, which was worked out to 4.99 per cent earlier and the cropping pattern tilted towards non-food grains, which were more remunerative. The yield rates of bajra, wheat, gram and sugarcane increased by 174.00 per cent, 41.94 per cent, 46.87 per cent and 20.83 per cent, respectively.

Chandrasekaran *et al.* (2004) studied participatory irrigation management for efficient water use and enhanced rice productivity in Tamil Nadu. The result revealed that, improved irrigation management reduced water use at the head and middle reaches and spared more water for farmers at the tail-end compared with the control. Under the control treatment, inadequate water supply at the tail-end area led to low rice yields, whereas the improved irrigation management permitted judicious use of water by the farmers and resulted in increased rice yields by 40.00 per cent at the head, middle and tail-end areas. Results indicated that farmers in an irrigation system could increase crop productivity through the judicious management of irrigation water and equal sharing of water from the head to the tail-end area.

Verma *et al.* (2004) in the study on National Watershed Development Programme revealed that the average yields per hectare of Soybean, Maize, Wheat and Potato were 15.66, 14.59, 2347, and 213.45 quintals, respectively in NWDPR area as compared to 10.54, 9.48, 14.76, and 153.34 quintals, respectively in non-NWDPR area.

Hosamani and Janawade (2005) studied the effects of irrigations and nutrient management on groundnut oil yield and characteristics of soil. Results of investigation revealed that, the scheduling of irrigations at pre-sowing, pegging, pod formation and pod filling stage recorded significantly higher oil yield (717 kg/ha) over farm practices (619 kg/ha).

Dasaratharamaiah *et al.* (2006) reported that 10.0 per cent of beneficiaries had income between 7,201 and above, 20.67 per cent had income between 4,801 to 7,200 and 31.33 per cent have income 3,601 to 4,800 and 38.00 per cent had income below 3,600 per annum after implementation of DWCRA. It was found that there were no persons without any income.

Shanthamani (2007) reported that the watershed programme has resulted in significant increase in socio-economic status (9.72) mean score, of land productivity increased in yield of red gram 1.20 q/acre and jowar 1.02 q/acre and annual income of beneficiaries increased to 22,950.

Savita (2008) reported that difference in crop productivity in the pre and post project period, in case of sugarcane increased from 35 tonnes/acre to 40 tonnes/acre rising by 5 tonnes/acre. Similarly, in case of red gram increased from 3.5 q/acre to 6.0 q/acre rising by 2.5 q/acre, jowar increasing from 8 q/acre to 13 q/acre rising by 5 q/acre. It was observed that, the increase in annual income of the beneficiaries in case of marginal farmers increased from Rs. 8,000 to Rs. 17000 followed by, semi medium from Rs. 13,000 to Rs. 26,000, medium from Rs. 19,000 to Rs. 37,000, big farmers income from Rs. 29,000 to Rs. 54,000 after implementation of the project.

Padma and Rathkrishnan (2011) revealed that increased income (90.00%), increased standard of living (79.16%), improved in existing lands (80.00%), purchase of additional livestock (70.83%), purchase of household appliances (78.25%), diversified cultivation (89.16%), increased savings (86.66%) *etc.* were the major impacts experienced by the respondents due to the adoption of precision farming.

2.6 Constraints faced in adoption of precision farming practices

Krause and Black (1995) found that when a decision has been made to adopt some aspect of precision agriculture, the timing of that adoption may be delayed by problems in the equipment replacement cycle for those underlying machines on which GPS, sensors and other electronics are to be installed.

Swinton *et al.* (1997) used focus groups to identify several barriers to adopting precision agriculture. Two of these barriers were concerns over the initial cost of the technologies and keeping up with technologies that are rapidly changing.

Kavitha (1999) stated that high investment cost was ranked as the major constraint by the drip users in the adoption of drip irrigation technology followed by delay in getting subsidy. cost of drip system hiked by the company while getting through subsidy was ranked as the third constraint by drip users in coconut where as drip users in grapes ranked clogging of emitters as the third major constraints in the adoption of drip irrigation technology.

Pedersen *et al.* (2000) found that the major problem in handling the precision agriculture was data is the time requirement, whereas 74.00 per cent of the Danish and 69.00 per cent of the American respondents found data handling too time consuming. Additional surveys have mentioned time requirement as one of the main impediment to precision agriculture adoption.

Ahire *et al.* (2003) proclaimed that 45.00 per cent of the farmers expressed that lack of knowledge on drip irrigation as the constraint and 42.00 per cent of drip irrigation users experienced difficulty in intercultural operation, whereas 85.00 per cent experienced problem in initial investment which they feel to be high and an another 65.00 per cent experienced delay in getting grants.

Singh and Bhimawat (2003) revealed that choking of drippers (84.44%), heavy investment for the installation of drip irrigation (99.33%), high technical competence required for operation and maintenance (70.67%) and problem in cleaning the laterals, filters and drippers (80.00%) were major constraint. Further they also stated irregular supply of electricity in study area (53.33%), damage by rats and squirrels (44.44%) were the other important constraints in the adoption of drip irrigation technology.

Keshavamurthy (2005) conducted a study on a study on contract farming in gherkin production, revealed that cent per cent of farmers expressed labour problem, followed by delayed payments (94.16%). The other constraints were low contract price (88.33%), high rejection rate (85.83%), problem of pests and diseases (77.00%) and manipulation of norms by firms (30.00%).

Sathysundaram (2006) conducted study on micro irrigation and drought management reported that initial cost of investment, lack of knowledge and trained human resource, lack of sufficient institutional and credit support as the major constraints experienced by the farmers.

Sudha (2008) enumerated constraints of the precision farming farmers as high cost of water soluble fertilizers (39.16%), delay in getting subsidy (30.83%), high investment cost for installation (20.83%), clogging of emitters (36.66%), poor quality of drip material (10.00%) and damage due to rats and rodents (22.5%).

Sangeetha (2009) found out that the constraints of the precision farming practices in tomato cultivation were clogging of emitters (46.36%), frequent cleaning of emitters (45.45%), poor quality of drip material (32.73%), damage due to rats and rodents (27.27%), difficulty to operate due to illiteracy (24.55%), difficulty in practicing intercultural operation (15.00%) and long time for getting subsidy (12.23%) respectively.

Senthilkumar (2009) concluded that the major problems perceived by the sample farmers with respect to performance of drip system was clogging of micro tubes followed by non-uniformity of discharge of water through drippers. Drip system required time to time attention for minor repairs, disconnection of laterals, main tubes and drippers and frequent cleaning of filters.

Padma and Rathkrishnan (2011) conducted study on precision farming, A comprehensive approach to farm planning in her study revealed that high cost of water soluble fertilizer (40.00%), followed by delay in getting subsidy (37.00%) were identified as the constraints faced by the majority of respondents.

Priya (2011) conducted study on comparative study on precision and conventional methods of onion cultivation in Theni district of Tamil Nadu in her study revealed that there was scarcity of labour (91.67%), followed by micronutrient deficiency in soil (63.33%), non-availability of inputs (23.33%) and low fertility of soil (36.67%) as their major physical constraints. 48.33 per cent of the farmers indicated that they lack proper technical guidance from the local horticultural officer and around forty per cent of the respondents expressed that they suffered out of lack of training in adopting drip irrigation. Low quality of dripping material (32.66%), difficulty in taking up intercultural operations (23.33%) were the technological constraints expressed by respondents.

Narayanaswamy *et al.* (2012) conducted a study on adoption of vegetable growers with respect to IPM practices in vegetable crops. It was observed that a high percentage of respondents (83.33%) expressed the problem of lack of knowledge regarding use of pheromone traps and bio-agents, followed by 78.66 per cent highlighted the constraints of Lack of knowledge about mechanical practices in management of pests. Heavy incidence of pest, lack of knowledge about preparation of NSKE, lack of knowledge about economic threshold level were other major constraints pointed out by 70.00, 68.00 and 65.33 per cent of respondents respectively.

Sangeetha *et al.* (2012) conducted study on constraints in the adoption of precision farming technologies in tomato cultivation. They reported that 78.18 per cent of the respondents expressed that cost of water soluble fertilizer was higher than the normal fertilizer. Half (54.54%) of the respondents felt that technologies like drip irrigation, fertigation and chemical pesticides are expensive when compared to conventional farming. Clogging of emitters as a constraint was reported by 46.36 per cent of precision farmers. Frequent cleaning of filters as a constraint was found to be expressed by 45.45 per cent of respondents. Poor quality of drip material was listed as a constraint by 32.73 per cent of precision farmers. Damage due to rats and rodents was one of the constraints expressed by 27.27 per cent of the respondents. Operation of drip system was difficult to illiterate people this was indicated as constraint by 24.55 per cent of the respondents.

Meti (2013) in his study on drip irrigation practices in Dharwad district reported that inadequate supply of electricity (100%), high initial investment (98%), inadequate follow of services by drip agencies (53.10%) and non-availability of soluble fertilizer were major constraint expressed by the drip irrigation farmer in drip irrigation adoption.

METHODOLOGY

The study was conducted during the year 2013-14 in Bagalkot, Belgaum, Dharwad and Haveri district of Karnataka. The research methodology and the procedure followed for conducting this study has been presented under the following headings.

- 3.1 Research design
- 3.2 Locale of the study
- 3.3 Brief description of the study area
- 3.4 Selection of the respondents
- 3.5 Operationalization and measurement of variables
- 3.6 Measurement of dependent variables
- 3.7 Measurement of independent variables
- 3.8 Constraints faced in adoption of precision farming practices
- 3.9 Procedure followed for data collection
- 3.10 Statistical tools used

3.1 Research design

As the events leading to perception of precision farming by the farmers had already happened, the 'Ex-post-facto' research design was considered as the most appropriate for the study and the same was adopted. It is a systematic empirical enquiry in which the researcher does not have direct control over the study variables because their manifestations have already occurred or because they are inherently not manipulable. Thus, the inferences about the relationships among variables are made without direct intervention from concomitant variation of independent and dependent variables.

3.2 Locale of the study

The study was purposively conducted in districts of Bagalkot, Belgaum, Dharwad and Haveri districts of North Karnataka state. These districts are purposively selected for research study as Precision Farming Project under RKVY was implemented by UAS Dharwad in these districts during the year 2011-2012.

3.3 Brief description of the study area

3.3.1 Belgaum district

Belgaum district is located at Northwest of Karnataka state between 15°23' to 16°58' N latitude and 74°05' to 75°28' longitude. It is surrounded by Bijapur, Bagalkot, Dharwad and Karwar district of Karnataka state and Sangli, Kolhapur, Ratnagiri district of Maharashtra state. The total geographical area of the district is 13,44,382 ha which stands second place in the state and it consists of ten taluks. The total cultivated land of the district is 10,51,947 ha and net irrigated area 4,85,039 ha. The district receives an average rainfall of 808 mm. The temperature ranges from a maximum of 38° C to the minimum of 12° C.

The major soils of this region are medium to deep clay with light black, reddish sandy and red sandy loam. Sugarcane, maize, cotton, tobacco, paddy, jowar, pulses, fruits and vegetables are main crops.

3.3.2 Haveri district

Haveri district is situated in northern part of Karnataka. It falls under northern transitional zone (zone-8). The Haveri district lies between 14° 28' and 14° 59' northern latitude and 75° 07' and 75° 38' eastern longitude. It is bounded by Dharwad and Gadag in the north, Davanagere and Shimoga in the south, Uttara Kannada in the west and Bellary in the east. The total geographical area of the district is 4,85,156 ha and total cultivated land of the district is 5,08,712 ha and net irrigated area 78,943 ha. The major soil types of the district are shallow to medium black, clay and red sandy loam soils found in equal proportions in the area. The soils are moderate in fertility status. The average annual rainfall

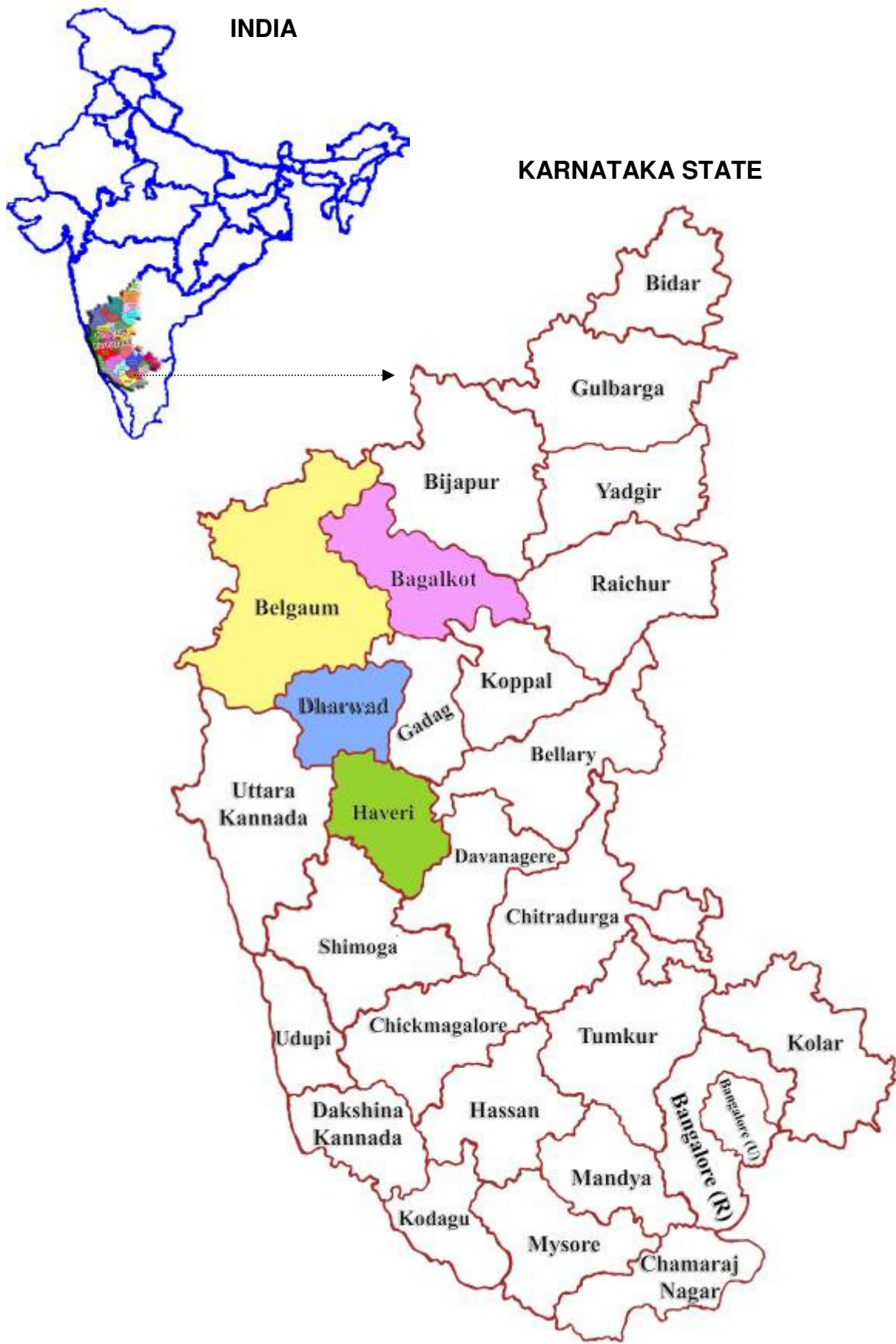


Fig. 1: Map of the study area

of the district is 752.0 mm. The temperature ranges from a maximum of 42⁰ C to the minimum of 16⁰ C. The important crops grown in the area are cotton, maize, chilli, sunflower, groundnut, wheat, safflower, paddy, green gram and sugarcane. The farmers in the study area take up the seed production of various crops viz., tomato, chilli, bhendi, jowar, maize, cotton, bajra sun flower etc.

3.3.3 Bagalkot district

The Bagalkot district is situated in northern part of the state. The district lies between 15⁰49' to 16⁰46' latitude and 74⁰59' to 76⁰20' longitude. The district is surrounded by Bijapur, Belgaum, Gadag, Koppal and Raichur districts. Bagalkot district consists of six taluks viz., Bagalkot, Bilagi, Badami, Jamakhandi, Mudhol and Hunagund. The temperature ranges from a maximum of 40⁰ C to the minimum of 12⁰ C. The major soil types of the district are medium black, red and sandy soils. Major crops grown are sugarcane, jowar, maize, wheat, redgram, begalgram, soybean, sunflower, groundnut cotton etc.

The total geographical area of the district is 6594 sq. km with the cultivable area of 5,12,748 ha and net irrigated area 2,76,315 ha. The district receives an average rainfall of 562 mm. The major sources of irrigation are canals, bore wells, wells and tanks with net irrigated area of 2, 00,241 ha.

3.3.4 Dharwad district

Dharwad district is situated in Northern part of Karnataka state at 74⁰ 28' North latitude and 14⁰ 31' East longitude. The district comes under the Northern Transitional Zone. It is bounded by the Belgaum in the North, Haveri in the South from Northeast to Southeast bounded by Uttar Kannada district and Northwest to Southwest it is bounded by Gadag district.

The district has healthy and conducive climate. The monsoon varies from April-May to September-October with two peaks, one in July and other in September creating two cropping seasons. The temperature ranges from a maximum of 39⁰C to minimum of 13⁰C. The types of soil ranges from shallow to black and medium red sandy loam. The annual rainfall ranging from 539.7 mm to 1037.2 mm, which is fairly well distributed from April-May to September-October.

The total geographical area of the district is 4,27,329 ha and cultivated area is 3,60,186 ha and net irrigated area 59,248 ha. The principal crops of the district are paddy, maize, jowar, soybean, groundnut, cotton, potato and vegetables in *Kharif* season. In Rabi season, major crops grown are wheat, *rabi* jowar and bengalgram.

3.4 Selection of the respondents

All the farmers covered under Precision Farming Project implemented by UAS Dharwad constituted in sample of the study. Purposive sampling procedure was followed for selection of respondents. Thus the total sample size constituted for the study was 76 respondents. The details of respondents selected from various villages are given in Table below.

3.4.1 District, Taluk and village wise number of respondents selected for the study

District	Taluk	Villages	No. of respondents
Bagalkot	Mudhol	Mudhol	02
	Jamakandi	Teradal	01
Belgaum	Hukkeri	Bellada bagewadi	25
		Kadatti	02
		Kotabagi	01
Dharwad	Kundagol	Kamadolli	03
		Hireharkuni	02
		Devanur	04
		Kundagol	02
Haveri	Shiggoa	Bisanalli	34
		Total	76

3.5 Operationalization and measurement of variables

3.5.1 Dependent variable

Considering the objectives of the study, the perception of precision farming by the farmers was selected as dependent variable.

3.5.2 Independent variables

Based on the previous research studies, review of literature, discussion with scientists and consultation with experts in the field, the probable variables influencing directly or indirectly on the perception of precision farming by the farmers were identified. These were age, family size, education level, land holding, annual income, extension contact, mass media participation, innovative proneness, crop productivity and material possession.

3.6 Measurement of dependent variable

3.6.1 Perception of precision farming by the farmers

Perception refers to an opinion or a subjective measurement on a certain object. It is a process by which individual organize and interpret their sensor impressions in order to give meaning to their environment (Levitt, 1958). It is the process by which an individual selects, organizes and evaluates stimuli from the external environment to provide meaningful expression for oneself.

Perception of precision farming is operationally defined as meaningful sensations of farmers about precision farming practices in meeting their needs.

A teacher made test to measure the perception of beneficiaries about precision farming practices was developed based on the suggestions of Anastasi (1961). As a first step, the available literature on precision farming was collected from books, journals and concern scientist. This was followed by indebt reviews of past studies on precision farming and a thorough elaborate discussion with a number of experienced extension personnel and concern scientists.

By this process 47 statements on perception of precision farming were identified. The statements so identified were carefully edited. Thorough review of literature and scrutinizing of experts established the content validity of the scale. In order to arrive at a comprehensive measurement procedure to measure perception of farmers, the selected statements were grouped under five components considering the perceived attributes of precision farming. The five attributes of precision farming were relative advantage, compatibility, complexity, trialability and observability. The attribute wise statement grouped were given below

Sl. No.	Attribute	Number of statements
1	Relative advantage	10
2	Compatibility	8
3	Complexity	10
4	Trialability	9
5	Observability	10
	Total	47

These 47 statements were administered to 76 respondents to assess their perception about precision farming practices. The responses of the respondents against each items was recorded on a five point continuum viz., strongly agree, agree, undecided, disagree and strongly disagree with scores 5, 4, 3, 2, 1, respectively. The total perception score for individual respondent was calculated by summing up the score of sub items as perceived by the individual farmer. Thus, 235 and 47 were the maximum and minimum scores obtained by the farmers.

3.7 Measurement of independent variables

3.7.1 Age

It was operationalised as the chronological age of the respondent in completed years at the time of investigation. The age of the respondents was recorded as mentioned by them. The

chronological age of the respondents in completed years was considered for all purposes of analysis. The respondents were further categorized into three age groups, based on the classification as followed by Madhu (2010).

Category	Age (in years)
Young age	Less than 31 years
Middle age	Between 31 to 50 years
Old age	More than 50 years

3.7.2 Education level

Education was operationalised as the extent of formal schooling undergone by the respondents. A score of one was given for each year of formal schooling completed. Further, the respondents were grouped into six categories based on procedure followed by Binkadkatti (2008) and Satish (2010).

Categories	Education level
Illiterate	Do not read and write
Primary school	1 st to 4 th Std
Middle school	5 th to 7 th Std
High school	8 th to 10 th Std
Pre-university	11 th and 12 th Std
Graduate	above 12th Std

3.7.3 Family size

Family size was operationalised as total number of members residing together in the family at the time of investigation. A score of one was assigned to each individual member of the family. Further, the size of the family was classified into three categories. Categorisation of the respondents was done in the following manner, as followed by Manjunath (2010).

Size of the family	Number
Small family	<5 members
Medium family	5-8 members
Large family	>8 members

3.7.4 Land holding

It refers to the number of acres of land possessed by the farmer. Further, based on the criterion prescribed by the Karnataka Land Reforms Act 38 of 1966 (part –B) 99, 195-96 under section 2 (a) 32 of equating one acre of irrigated or garden land to 3 acres of dry land was used to convert irrigated and garden land to dry land. A score of one was given for each standard acre of land owned. The criterion prescribed by Ministry of Rural Development, Government of India vide circular No. 280-12/16/19 RD-III (Vol. II) dated 15th November 1991 (Anonymous, 1992) and as followed by Maraddi (2006) the respondents were grouped into five categories.

Category	Land holding (in acres)
Marginal farmers	Up to 2.50
Small farmers	2.51 to 5.00
Semi-medium farmers	5.01 to 10.00
Medium farmers	10.01 to 25.00
Big farmers	Above 25.00

3.7.5 Annual income

It was operationalised by considering the total income earned by the respondents from both agriculture and allied enterprises during last one year as expressed in rupees. Further, based on the classification of the Ministry of Rural Development, Government of India. Notification- June, 2011 to conduct the Socio Economic and Cast Census in the year 2011 (Anonymous, 2011) and as followed by Taskeen (2012), the respondents were grouped in three categories.

Category	Annual Income (in Rs)
Low income	<Rs. 60,000
Medium income	Rs. 60,000 to 1,20,000
High income	>Rs. 1,20,000

3.7.6 Mass media participation

This variable is operationalised as the exposure of an individual to different mass media channels such as newspaper, farm magazine, radio, television and his degree of participation in them. The respondent was asked to indicate whether he subscribed to or own the media. Then, the respondent was asked to indicate his degree of exposure in terms of reading habit, listening behavior and viewing habit. This variable was quantified on the basis of the procedure followed by Hinge (2009). Higher score reveals greater participation in mass media by the respondent.

Subscription / Possession	Score
Subscriber / Owned	1
Non-subscriber / Not-owned	0
Reading / Listening / Viewing habit	
Regularly	2
Occasionally	1
Never	0

Further, based on the total scores of mass media exposure, the respondents were classified into three categories such as 'low', 'medium' and 'high' by considering mean (\bar{X}) and standard deviation (SD) as a measure of check.

Category	Score
Low	Less than (Mean – 0.425 SD)
Medium	Between (Mean \pm 0.425 SD)
High	More than (Mean + 0.425 SD)

3.7.7 Extension contact

It refers to the extent of contacts of the farmers with different extension agencies like AAs, AAOs, ADA, University Scientist *etc.* In the present study, extension contact was measured considering the frequency of meeting of farmers with extension agency on five point continuum, namely, 'never', 'whenever problem arise', 'once in a month', 'once in two weeks' and 'once in a month' with the scores of 0,1,2,3 and 4, respectively. The higher score reveals more number of contacts with extension personnel by the respondent. The variable was quantified on the basis of procedure as followed by Madhu (2010).

Frequency of contact	Score
Never	0
Whenever problem arises	1
Once in a month	2
Once in two weeks	3
Once in a week	4

Based on the total scores of extension contact, the respondents were classified into three categories such as 'low', 'medium' and 'high' by considering mean (\bar{X}) and standard deviation (SD) as a measure of check as detailed below.

Category	Score
Low	Less than (Mean – 0.425 SD)
Medium	Between (Mean \pm 0.425 SD)
High	More than (Mean + 0.425 SD)

3.7.8 Innovative proneness

Innovative proneness was operationalised as the behavior pattern of an individual who has interest and desire to seek changes in farming techniques and ready to introduce such changes when practical and feasible. It was measured by procedure followed by Hagemanty (2011). The procedure consisted of five statements. Of the five statements, the statements 2, 3 and 5 are negative. The response for each statement were rated on five point continuum ranging from strongly agree to strongly disagree with the scores of 5, 4, 3, 2 and 1 for positive statements and 1, 2, 3, 4 and 5 for negative statements, respectively. The minimum and maximum scores were 5 and 25, respectively. Based on the total scores obtained by the respondents, the mean and standard deviation were arrived at. Using mean and standard deviation, respondents were divided in to three categories as shown below

Category	Score range
Low	Below (Mean - 0.425 S. D.)
Medium	Between (Mean +/- 0.425 S. D.)
High	Above (Mean + 0.425 S. D.)

3.7.9 Material possession

It refers to the possession of various farm implements and household materials such as wooden plough, iron plough, mould board plough, seed drill, seed-cum-fertilizer drill, power tiller, harrow, cultivators, knapsack sprayer, power sprayer, tractor, bicycle, motor cycle, radio, television, mobile phone, gobar gas, thresher, pump sets and bullock cart utilized for agricultural operations in the farm by an individual farmer.

Further, to place the respondent at different level with respect to material possession the scoring and categorization was done by using the procedure followed by Jyoti Goravi (2012) and Binkadkatti (2013) with slight modifications

The items included under different heads and the respective weights assigned to them were as follows:

Sl.No.	Items included	No	Scoring
A)	Agriculture implements		
1	Wooden plough	1	2
2	Mould board plough	1	2
3	Iron plough	1	2
4	Seed drill	1	2
5	Harrow	1	2
6	Seed cum fertilizer drill	1	2
7	Cultivators	1	2
8	Bullock cart	1	2
9	Power tiller	1	2
10	Knap sack sprayer	1	1

11	Power sprayer	1	2
12	Tractor	1	3
13	Thresher	1	3
14	Pump sets	1	2
B)	House hold materials		
1	Motor cycle	1	1
2	Radio	1	1
3	Television	1	2
4	Mobile phone	1	2

Based on the total scores, the respondents were classified into three categories such as 'low', 'medium' and 'high' by considering mean (X) and standard deviation (SD) as a measure of check.

Category	Score
Low	Less than (Mean – 0.425 SD)
Medium	Between (Mean ± 0.425 SD)
High	More than (Mean + 0.425 SD)

3.7.10 Crop productivity

The level of yield obtained by farmers is a good indicator of the crop productivity. The yield obtained with respect to crops by the respondents in the previous season was considered in terms of quintals per acre (qtl/acre) or tonnes per acre (tonne/acre). The procedure followed by Shantamani (2007) was adopted with suitable modifications to quantify this variable.

Productivity is the average crop yield of the respondents in an acre of land.

$$\text{Crop Productivity} = \frac{\text{Total crop yield}}{\text{Total area of crop grown}} \times 100$$

3.8 Constraints faced in adoption of precision farming practices

To know the constraints faced in adoption of precision farming practices from the farmer's point of view a list of constraints were prepared after extensive review of literature, consulting expert in the field and the respondents were asked to give their opinion by answer 'Yes' or 'No'. The frequency of constraints as indicated by the farmers was the basis for ranking of the constraints.

3.9 Procedure followed for data collection

Keeping in view the objectives and variables of the study, a structured interview schedule was developed by consulting experts and referring to the relevant literature. Since all the farmers who have adopted the precision farming practices were considered as a sample for the study. Hence, it was not possible to conduct the pre-testing of interview schedule with non-sample farmers.

The final format of the interview schedule is given in Appendix I. The data were collected from the respondents through personal interview method in an informal atmosphere by establishing a good rapport by convincing them the purpose and importance of the study.

3.10 Statistical tools used

The following statistical tools were made use of in the study to analyze the data.

3.10.1 Mean: The arithmetic mean is the sum of the scores divided by their number. This measure was used to categorize the independent variables into low, medium and high categories.

3.10.2 Frequency: This measure was used to know the distribution pattern of respondents variable wise and to categorize the problems perceived by precision farmers in order of importance.

- 3.10.3 **Percentage:** This measure was used for simple comparisons and to express the attributes of precision farming.
- 3.10.4 **Standard deviation:** It was defined as the square root of the arithmetic mean of the sum of the square of the deviation taken from the arithmetic mean. This measure was used to categorize the independent variables into low, medium and high categories.
- 3.10.5 **t-test:** t test was employed to find out the significant difference, if any between the mean score of two groups.
- 3.10.6 **Correlation:** Karl Pearson's product moment correlation coefficient (Simple correlation coefficient) was employed as to assess the relationship between the dependent and independent variables.
- 3.10.7 **Multiple linear regression analysis:** This analysis was used to find the contribution of the independent variables to the perception of precision farming.

RESULTS

Keeping the objective of the study in view, the findings of the investigation are presented in this chapter under the following heads.

- 4.1 Profile of the farmers
- 4.2 Perception of precision farming practices
- 4.3 Relationship of independent variables with perception of precision farming
- 4.4 Contribution of independent variables to the perception of precision farming practices.
- 4.5 Impact of precision farming on crop productivity and income of farmers
- 4.6 Constraints faced by precision farming farmers in the adoption of precision farming practices

4.1 Profile of the farmers

In order to have a better understanding of the precision farming farmers, they were analysed for some of their personal characteristics and the results to this effect are presented in Table 1.

4.1.1 Personal and socio-economic characteristics of the farmers

4.1.1.1 Age

An insight into the Table 1 and Fig 2 indicates that, 60.53 per cent of farmers belonged to middle age category, followed by old age (26.32%) and young age category (13.15%).

4.1.1.2 Education level

The data in Table 1 and Fig 2 revealed that, 25.00 per cent and 22.37 per cent of the farmers studied up to high school and PUC, respectively, while 17.11 per cent of them were illiterates. Only 14.47 per cent and 13.16 per cent of the farmers studied up to graduate and above, and middle school, respectively. A meager percentage (7.89%) of the farmers studied up to primary school.

4.1.1.3 Family size

The results presented in Table 1 and Fig 2 showed that more than half (55.26%) of the farmers belonged to medium size family (5 to 8 members) whereas, 18.42 per cent belonged to large size family (>8 members) and the remaining 26.32 per cent were found to have small size family (<5 members).

4.1.1.4 Land holding

The look into Table 1 and Fig 2 revealed that, 40.79 per cent farmers belonged to medium land holding, followed by 30.26 per cent and 18.42 per cent of the farmers were big and semi medium farmers, respectively. A meager percentage of the farmers were small (7.89%) and marginal (2.63%) farmers.

4.1.1.5 Annual income

It was noticed in Table 1 and Fig 2 that, majority (72.37%) of the farmers belonged to high income category, while only 17.11 per cent and 10.53 per cent farmers belonged to medium and low income categories, respectively.

4.1.1.6 Mass media participation

An examination of the contents of Table 2 and Fig 3 revealed that among the different mass media studied, television (96.05%) was possessed by almost all the farmers, followed by news papers which were subscribed by 46.05 per cent and radio was possessed by 30.26 per cent of the farmers. A meager percentage (7.89%) of the farmers subscribed farm magazine.

As far as the utilization of these media by the farmers is concerned, it could be seen that 63.53 per cent of farmers never watched agriculture programmes in television (TV), whereas majority of farmers (67.10%) watched entertainment programmes regularly. While 43.42 per cent of farmers watched news programmes in occasionally.

Table 1: Personal characteristics of the farmers**(n = 76)**

Sl. No.	Category	f	%
1	Age		
	Young age (<30years)	10	13.15
	Middle age (31-50 years)	46	60.53
	Old age (>50 years)	20	26.32
	$\bar{X} = 45.59$	SD = 8.82	
2	Education level		
	Illiterate	13	17.11
	Primary school (1 st -4 th)	6	7.89
	Middle school (5 th -7 th)	10	13.16
	High school (8 th -10 th)	19	25.00
	PUC	17	22.37
	Graduate and above	11	14.47
	$\bar{X} = 9.8$	SD = 4.3	
3	Family Size		
	Small family (<5members)	20	26.32
	Medium family (5-8 members)	42	55.26
	Big family (>8 members)	14	18.42
	$\bar{X} = 6.85$	SD = 3.39	
4	Land holding		
	Marginal farmers (<2.5 acre)	2	2.63
	Small farmers (2.51 to 5.00 acre)	6	7.90
	Semi medium (5.01 to 10.00 acre)	14	18.42
	Medium farmers (10.01 to 25.00 acre)	31	40.79
	Big farmers (>25.00 acre)	23	30.26
	$\bar{X} = 22.50$	SD = 21.30	
5.	Annual income		
	Low income (<Rs 60,000)	8	10.52
	Medium income (Rs 60,000 to 1,20,000)	13	17.11
	High income (>Rs 1,20,000)	55	72.37
	$\bar{X} = 264671.1$	SD = 224967.1	

f. – Frequency

% - Percentage

 \bar{X} = Mean

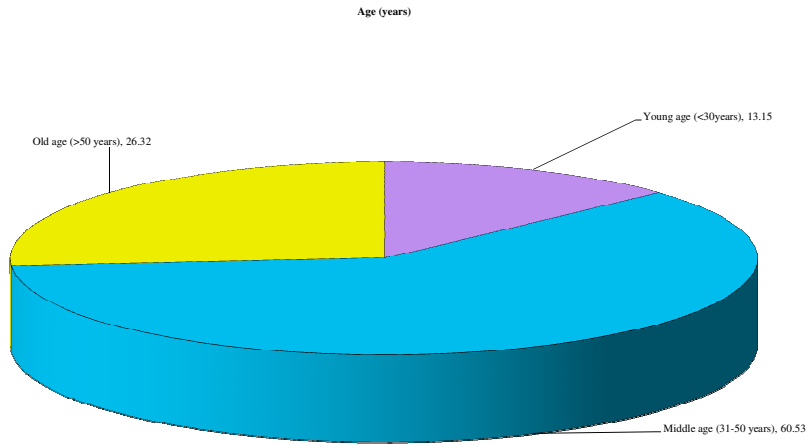


Fig. 2: Personal characteristics of the farmers

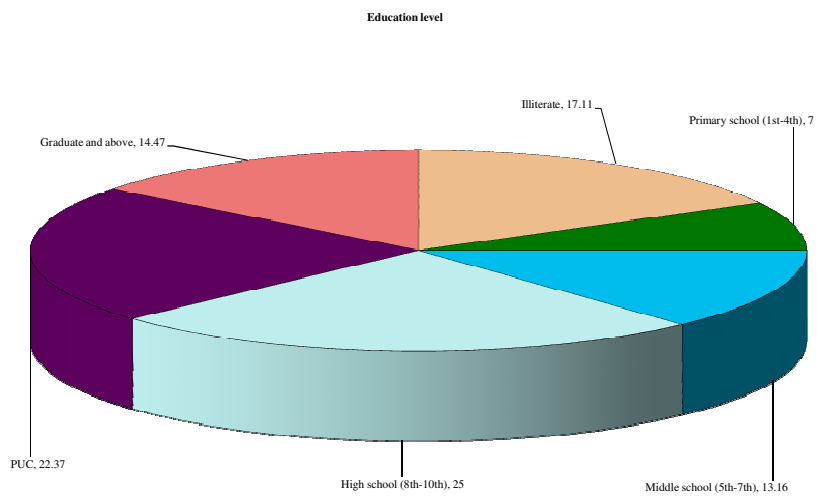
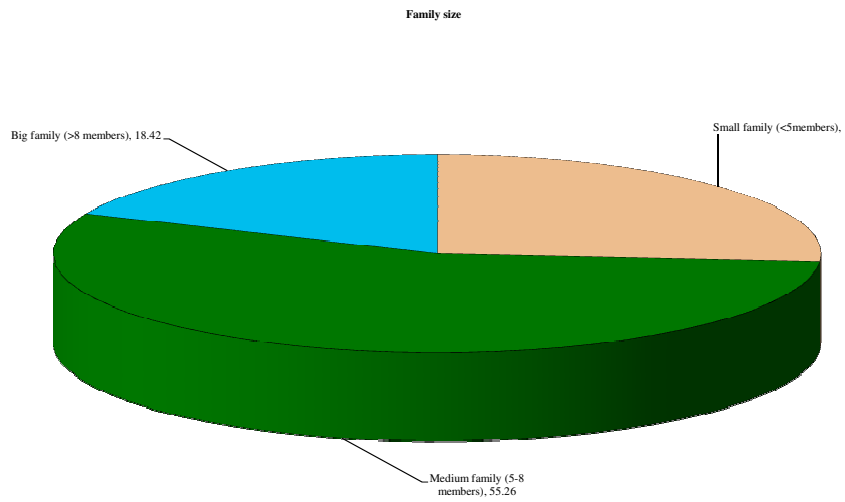


Fig 2. Personal characteristics of the farmers

Fig 2. Contd.....

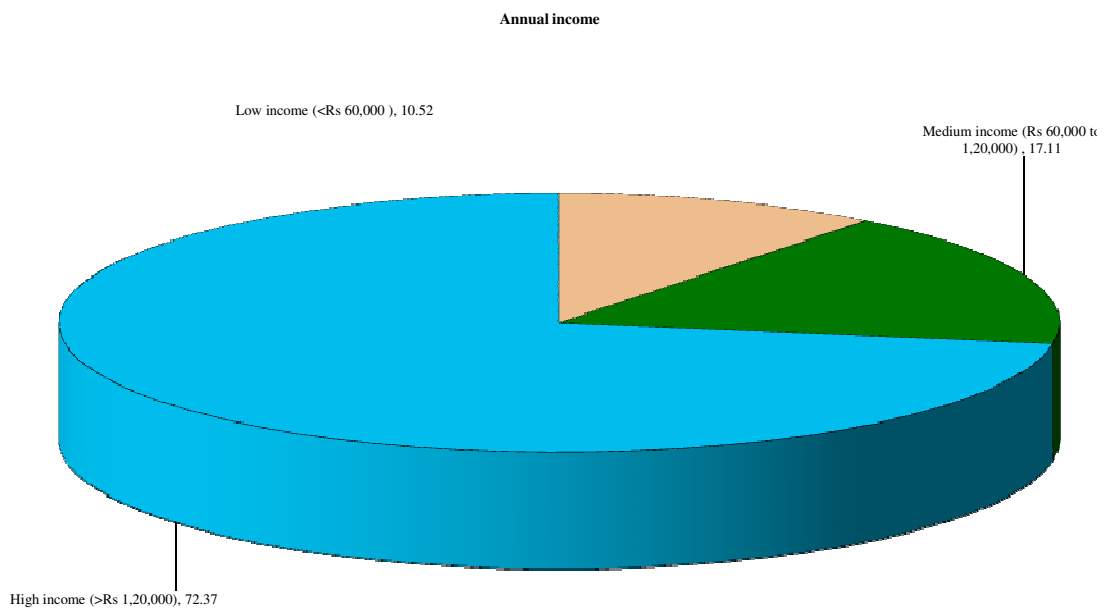
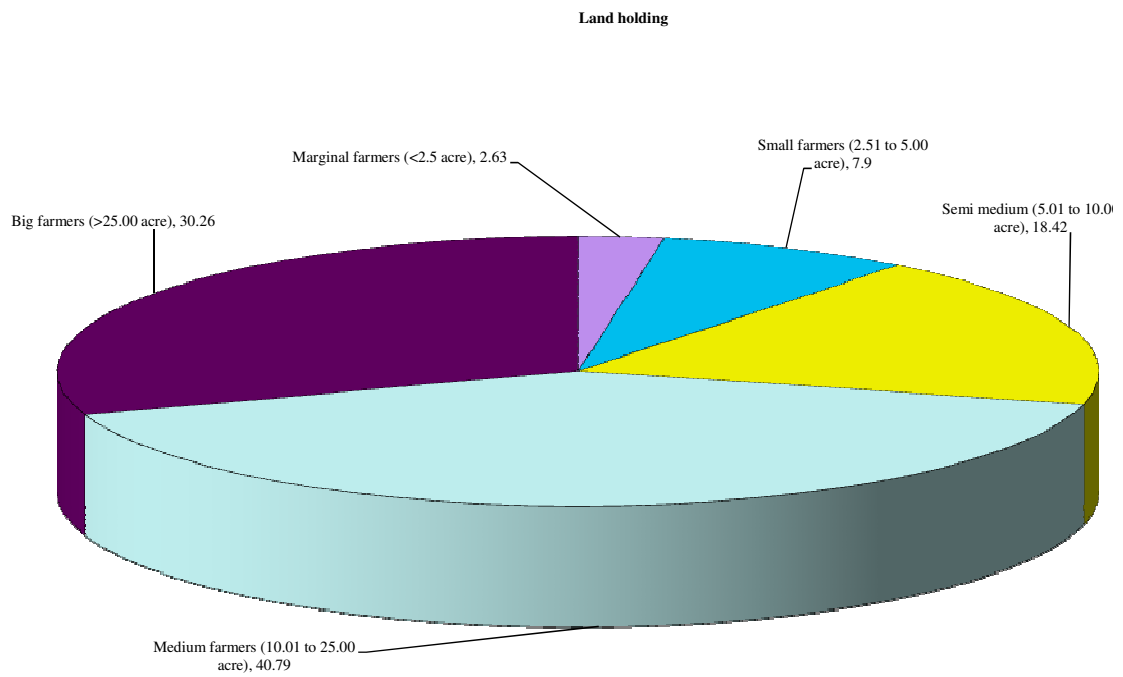


Table 2: Mass media participation of the farmers

(n = 76)

SI.No	Name of media	Subscribed/possessed	Programmes	Extent of use/ Participation		
		f (%)		Regular	Occasional	Never
				f (%)	f (%)	f (%)
1	News paper	35 (46.05)	Agril. Articles	6 (7.84)	21 (27.63)	49 (64.47)
			News	33 (43.42)	19 (25.00)	24 (31.58)
			Entertainment	12 (15.79)	21 (27.63)	43 (56.58)
2	Farm Magazines	6 (7.89)	Agril. Articles	4 (5.26)	11 (14.47)	61 (80.26)
			News	5 (6.57)	16 (21.05)	55 (72.37)
			Entertainment	3 (3.95)	9 (11.84)	64 (84.21)
3	Radio	23 (30.26)	Agril. programme	9 (11.84)	32 (42.11)	35 (46.05)
			News	16 (21.05)	34 (44.74)	26 (34.21)
			Entertainment	33 (43.42)	20 (26.32)	23 (30.26)
4	TV	73 (96.05)	Agril. programme	12 (15.79)	18 (23.68)	46 (60.53)
			News	22 (28.95)	33 (43.42)	21 (27.63)
			Entertainment	51 (67.10)	21 (27.63)	4 (5.26)

f. – Frequency

% - Percentage

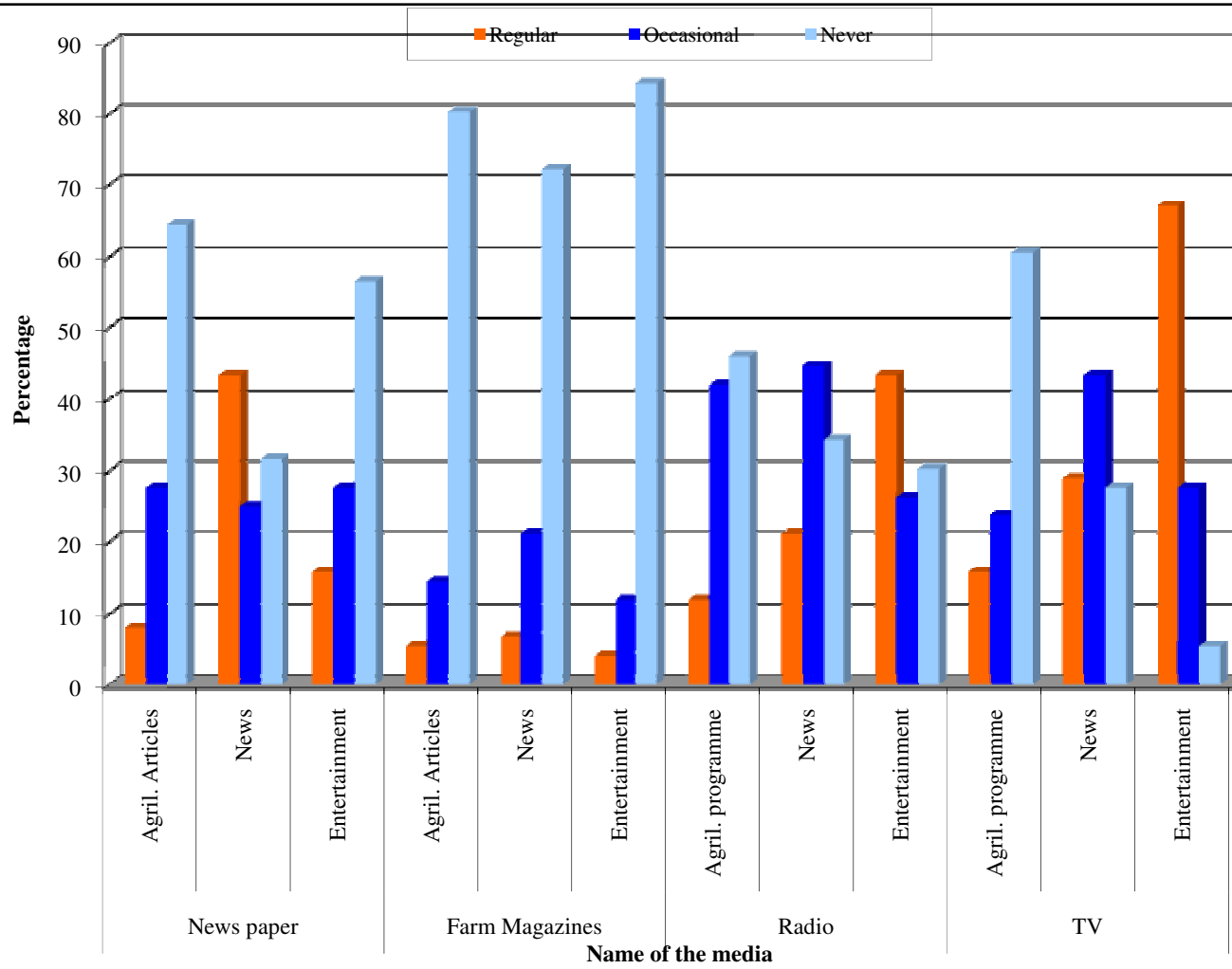


Fig. 3: Mass media participation of the farmers

In case of radio, 46.05 per cent of the farmers never listened to agriculture programmes, whereas 44.74 per cent of the farmers occasionally listened to news and 43.42 per cent of the farmers listen to entertainment programmes regularly.

Among the news paper readers, majority of the farmers never read agricultural article (64.47%) and entertainment article (56.58%). Whereas 43.42 per cent of the farmers read news articles regularly. Similarly majority of the farmers never read agriculture article (80.26%), entertainment article (84.21%) and news articles (72.37%) published in farm magazines.

It is evident from the data in Table 2.1 and Fig 4 that, more than half of the farmers (53.95%) belonged to medium mass media participation category, followed by low (26.32%) and high (19.74%) categories.

4.1.1.7 Extension contact

It is clear from Table 3 and Fig 5 that, 32.89 per cent of the farmers contacted Agriculture Assistants once in a month, while, 30.26 per cent, 36.84 per cent and 31.58 per cent of the farmers contacted Assistant Agriculture Officers, Agriculture scientists and input dealers whenever necessary, respectively. Half of the farmers never consulted Agriculture officer (50.00%) based at Raith Sampark Kendra and Assistant Directors of Agriculture located at taluk level was never consulted by 56.58 per cent of the farmers for agriculture information.

It was clear from the Table 3.1 and Fig 6 that 42.10 per cent of the farmers had medium level of extension contact, while 34.21 per cent and 23.68 per cent of them had high and low levels of extension contact, respectively.

4.1.1.8 Innovative proneness

The results presented in Table 4 and Fig 7 revealed that, 51.32 per cent of farmers had medium level of innovative proneness, while 26.31 and 23.37 per cent of farmers had high and low level of innovative proneness categories, respectively.

4.1.1.9 Material possession

The results presented in Table 5 and Fig 8 revealed that large majority of the farmers possessed television (96.05%), knapsack sprayer (92.10%), motor cycle (89.47%), seed drill (88.15%), mobile phone (88.15%), bullock cart (86.84%), harrow (84.21%) and wooden plough (80.26%). Whereas majority of the farmers possessed power sprayer (77.63%), cultivators (61.84%), iron plough (57.89%), tractor (56.57%) and seed-cum-fertilizer drill (52.63%).

Less than half of the farmers possessed mould board plough (40.78%), pumpsets (36.84%), thresher (34.21%) and radio (30.26%). A negligible percentage of farmers possessed power tiller (2.63%).

It can be observed from Table 5.1 and Fig 9 that, more than half of the farmers (55.26%) belonged to medium level category of material possession, followed by high level (30.26%). A meager percentage (14.47%) of the farmers belonged to low level material possession category.

4.1.1.10 Crop productivity

The average productivity of major crops obtained by the farmers is given Table 6 and Fig 10. The average productivity of the sugar cane was 42.30 t/ac and more than half of sugar cane growers (58.06%) obtained yield above average productivity, whereas 41.93 per cent obtained yield below average productivity. The average productivity of the maize, turmeric, wheat, cotton, soybean, chilli and ground nut were 25.10, 24.24, 6.78, 8.13, 7.68, 4.04 and 6.60 10 q/ac, respectively. Further majority of maize (66.15%), turmeric (58.82%), wheat (54.16%) and soybean (76.00%) growers obtained the yields above average productivity, whereas majority of cotton (57.14%), chilli (72.00%) and ground nut (60.00%) growers obtained yield below average productivity.

4.2 Attribute wise perception of precision farming practices by the farmers

The data pertaining to perception of various attributes of precision farming practices and perception of precision farming as whole are presented in Table 7.

Table 2.1: Distribution of the farmers according to mass media participation**(n = 76)**

Category	f	%
Low (<8.57)	20	26.31
Medium (8.57-10.58)	41	53.95
High (>10.58)	15	19.74
Mean = 9.57	SD = 2.36	

f. – Frequency % - Percentage

Table 3: Extension contact of the farmers**(n = 76)**

Sl. No.	Extension worker	Frequency of contact				
		Once in a week	Once in a fortnight	Once in a month	Whenever necessary	Never
		f (%)	f (%)	f (%)	f (%)	f (%)
1	Agriculture Assistant	6 (7.89)	15 (19.74)	25 (32.89)	21 (27.63)	9 (11.84)
2	Assistant Agriculture Officers	4 (5.26)	14 (18.42)	22 (28.94)	23 (30.26)	13 (17.10)
3	Agriculture Officers	6 (7.89)	8 (10.53)	9 (11.84)	15 (19.74)	38 (50.00)
4	Assistant Director of Agriculture	3 (3.95)	7 (9.21)	11 (14.47)	12 (15.79)	43 (56.58)
5	Agril.scientist	5 (6.57)	12 (15.79)	11 (14.47)	28 (36.84)	20 (26.32)
6	Input dealer	8 (10.53)	16 (21.05)	17 (22.37)	24 (31.58)	11 (14.47)
7	Extension personnel of other organization	5 (6.58)	14 (18.42)	16 (21.05)	18 (23.68)	23 (30.26)

f. – Frequency % - Percentage

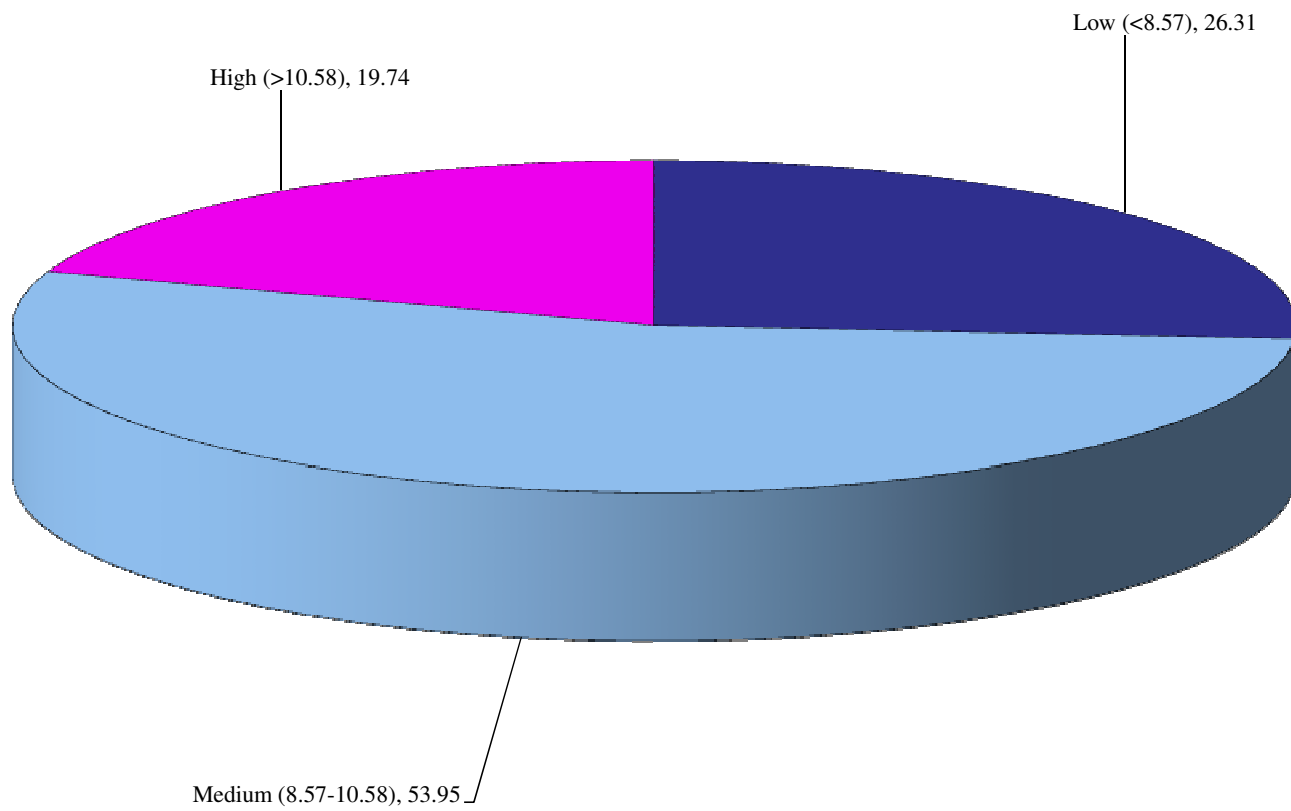


Fig. 4: Distribution of the farmers according to mass media participation

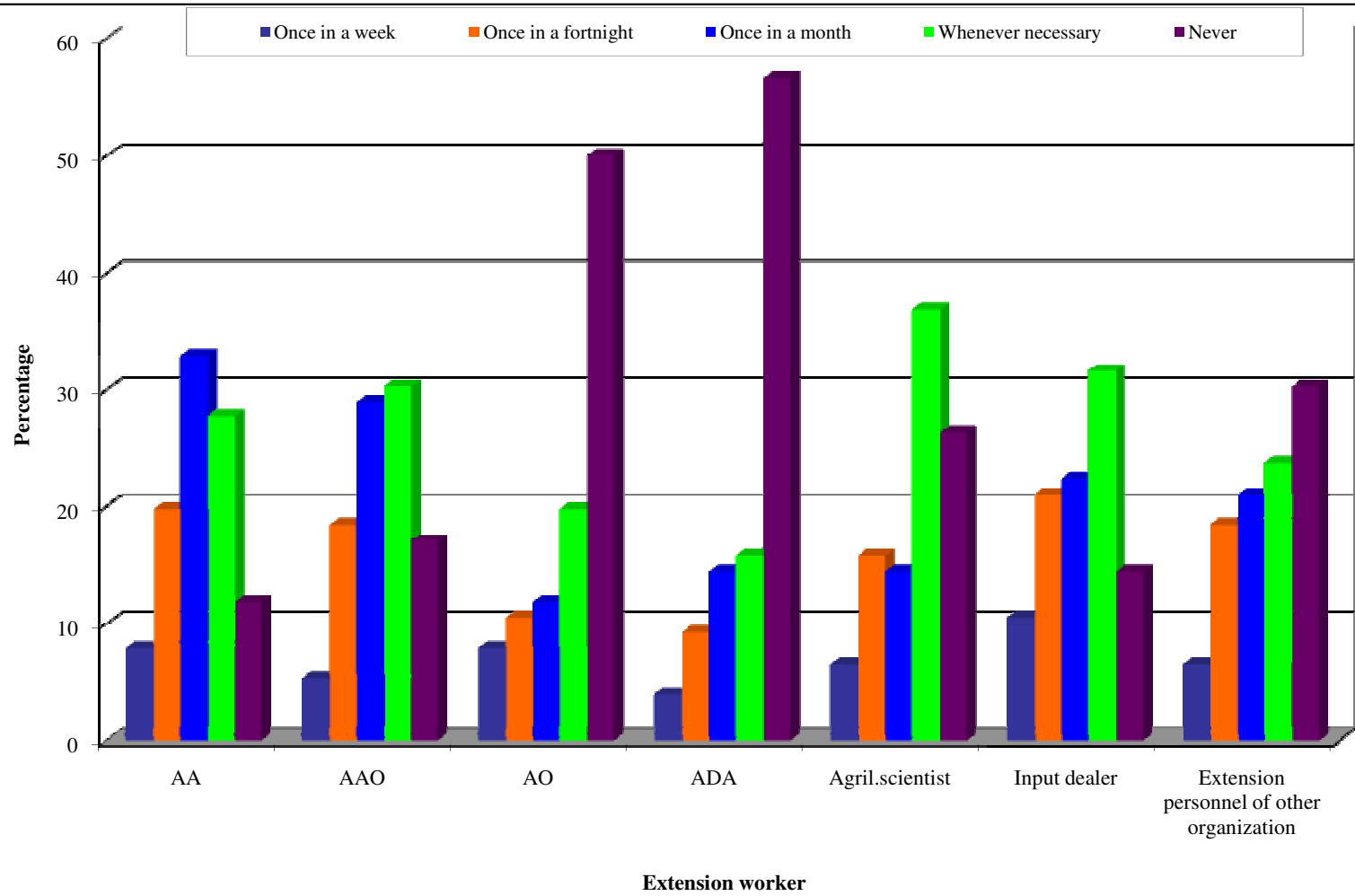


Fig. 5: Extension contact of the farmers

Table 3.1: Distribution of the farmers according to extension contact**(n = 76)**

Category	f	%
Low (<7.03)	18	23.68
Medium (7.03-9.04)	32	42.10
High (>9.04)	26	34.22
Mean = 8.03	SD = 2.37	

f. – Frequency % - Percentage

Table 4: Innovative proneness of the farmers**(n = 76)**

Category	f	%
Low (< 18.51)	20	22.37
Medium (18.51-20.58)	25	51.32
High (>20.58)	31	26.31
Mean = 14.01	SD = 3.10	

f. – Frequency % - Percentage

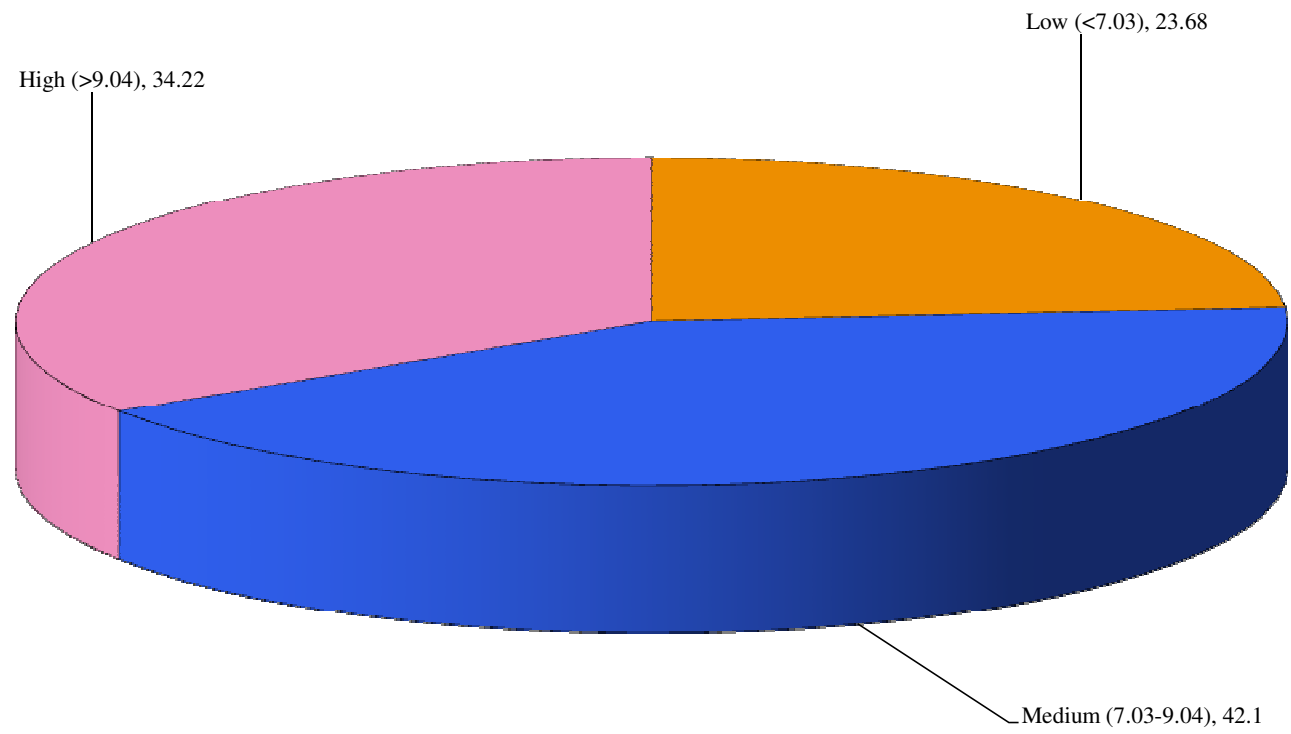


Fig. 6: Distribution of the farmers according to extension contact

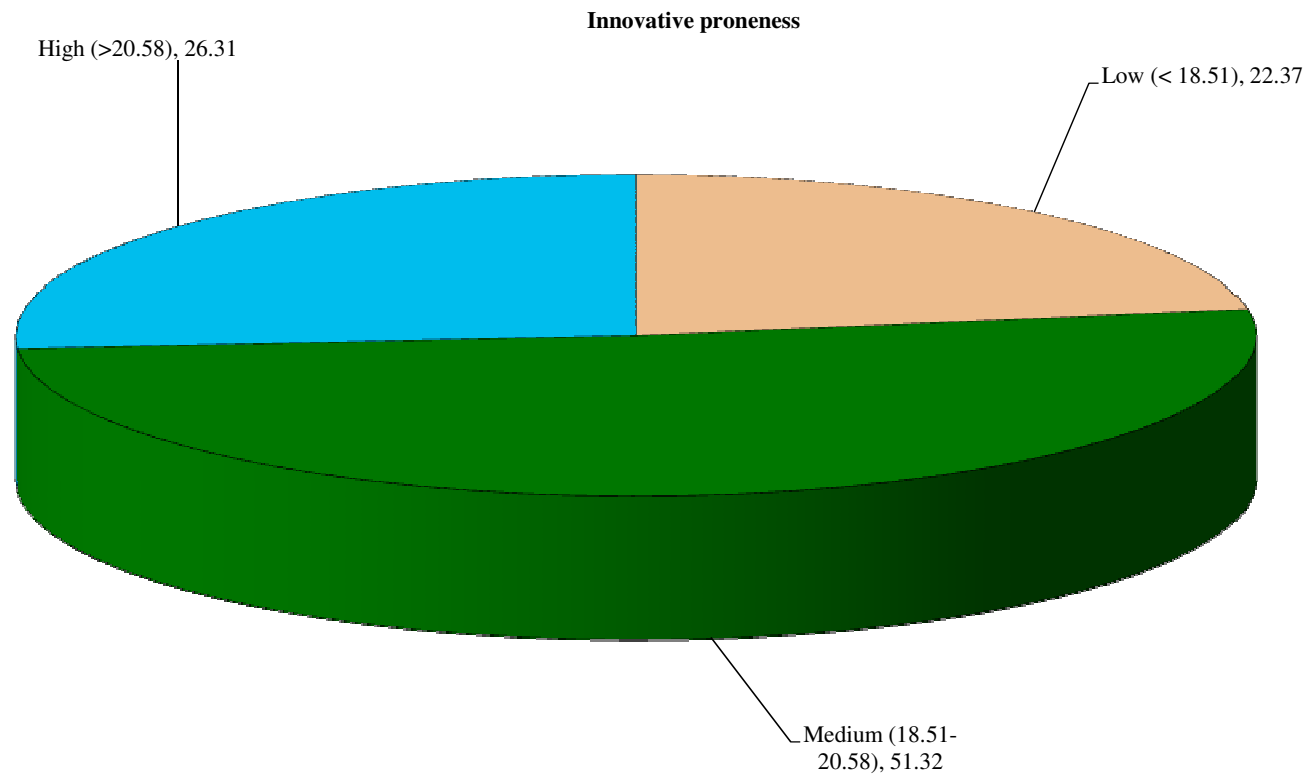


Fig. 7: Distribution of the farmers according to innovative proneness

Table 5: Material possession of the farmers**(n = 76)**

Sl. No.	Categories	f	%
1.	Television	73	96.05
2.	Knapsack Sprayer	70	92.10
3.	Motor Cycle	68	89.47
4.	Seed drill	67	88.15
5.	Mobile phone	67	88.15
6.	Bullock cart	66	86.84
7.	Harrow	64	84.21
8.	Wooden plough	61	80.26
9.	Power Sprayer	59	77.63
10.	Cultivators	47	61.84
11.	Iron plough	44	57.89
12.	Tractor	43	56.57
13.	Seed-cum-fertilizer drill	40	52.63
14.	Mould board plough	31	40.78
15.	Pumpsets	28	36.84
16.	Thresher	26	34.21
17.	Radio	23	30.26
18.	Power tiller	2	2.63

Table 5.1: Distribution of the farmers according to material possession**(n = 76)**

Category	f	%
Low (<15.67)	11	14.47
Medium (15.67-19.66)	42	55.26
High (>19.66)	23	30.26
Mean = 17.67	SD = 4.70	

f. – Frequency

% - Percentage

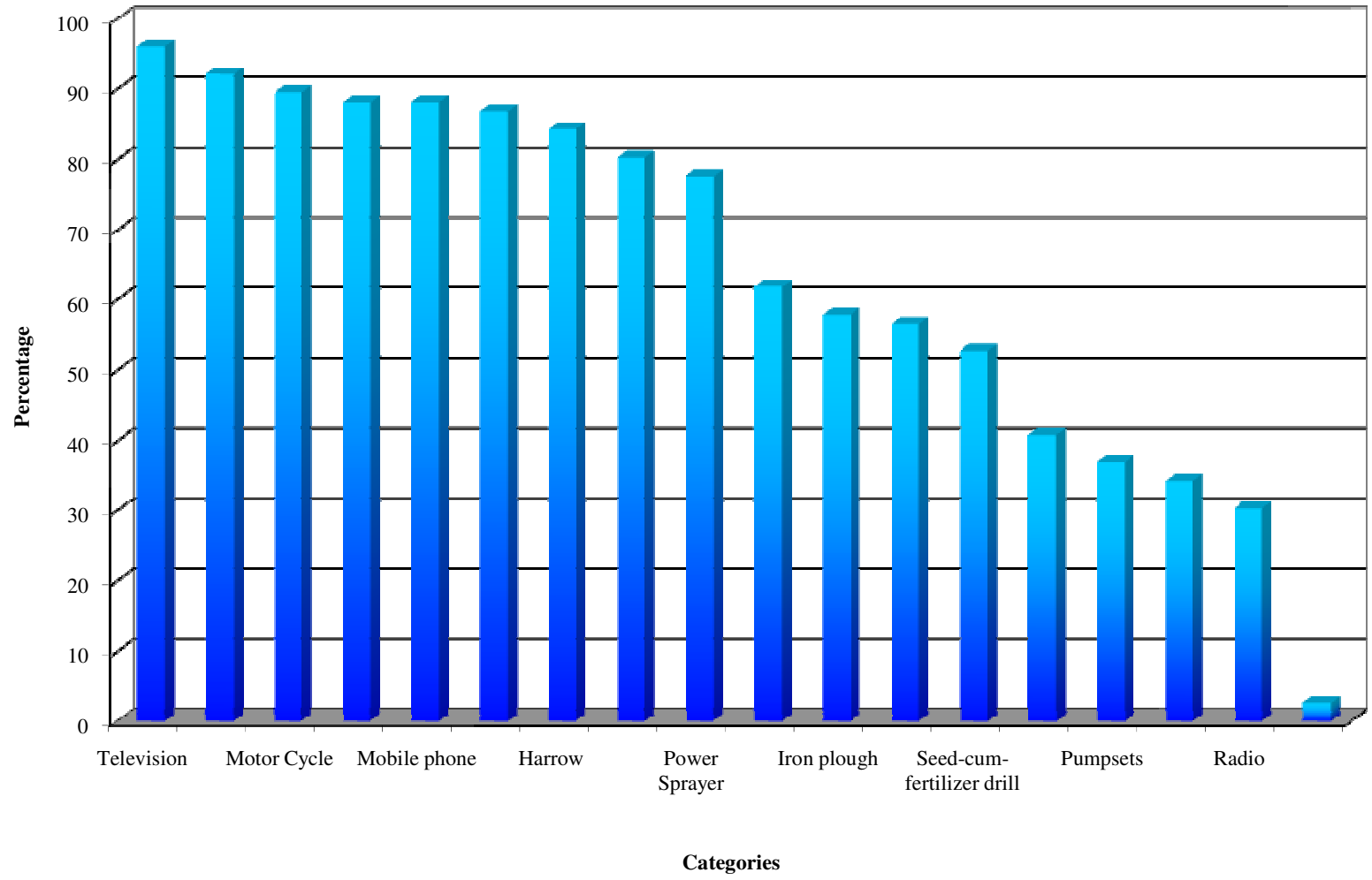


Fig. 8: Material possession of the farmers

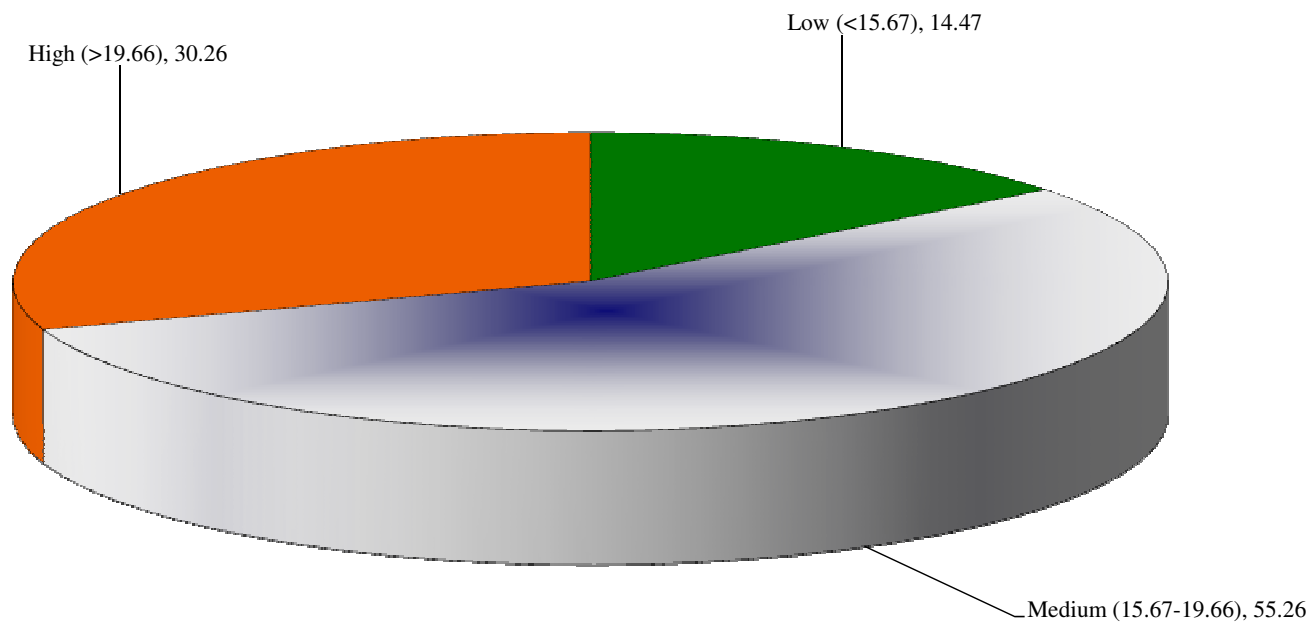


Fig. 9: Distribution of the farmers according to material possession

Table 6: Crop productivity of major crops grown by the farmers**(n = 76)**

Sl. No.	Crops	Average productivity	Above Average productivity		Below Average productivity	
			f	%	f	%
1	Sugar cane (t/ac) (n ₁ = 31)	42.30	18	58.06	13	41.93
2	Maize (q/ac) (n ₂ = 65)	25.10	43	66.15	22	33.84
3	Turmeric (q/ac) (n ₃ = 17)	24.24	10	58.82	7	41.18
4	Wheat (q/ac) (n ₄ = 24)	6.78	13	54.16	11	45.83
5	Cotton (q/ac) (n ₅ = 42)	8.13	18	42.85	24	57.14
6	Soyabean (q/ac) (n ₆ = 25)	7.68	19	76.00	6	24.00
7	Chilli (q/ac) (n ₇ = 16)	4.04	7	43.75	9	56.25
8	Ground nut (q/ac) (n ₈ = 15)	6.60	6	40.00	09	60.00

f – Frequency

% - Percentage

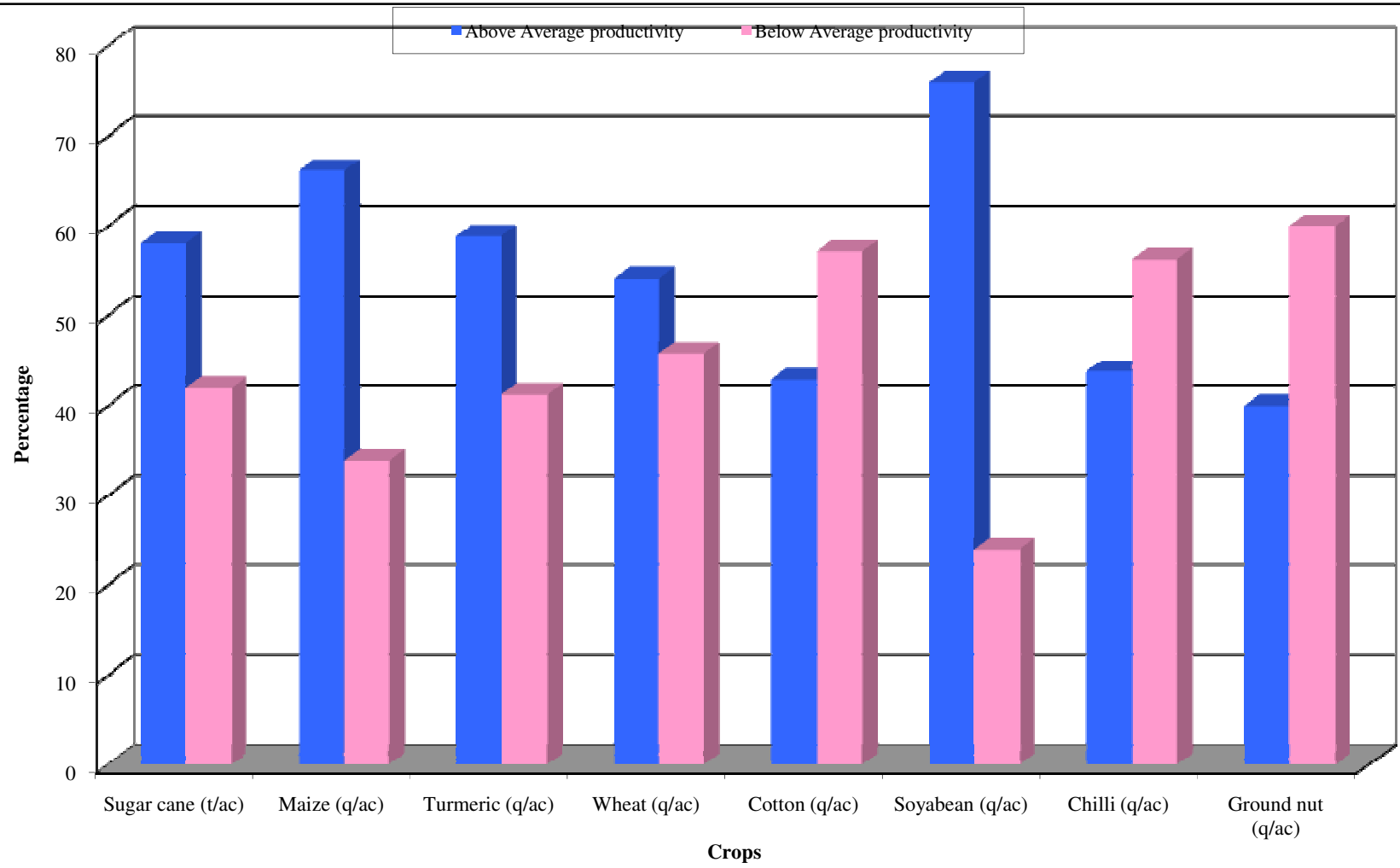


Fig. 10: Crop productivity of major crops grown by the farmers

4.2.1 Relative advantage

The results in the Table 7 and Fig 11 pertaining to relative advantage indicated that majority of the farmers strongly agreed with precision farming helps to apply nutrients based on soil variability (80.26%). Adoption of precision farming practices increases the yield was strongly agreed by 68.42 per cent, which was followed by application of nutrients based on soil variability results in balanced application of nutrients (67.11%), application of nutrients based on soil variability results increase nutrient use efficiency and there by increases net profit (61.84%) and timely management of cultivation practices increase quality of the produce (51.32%).

The Table also revealed that majority of the farmers agree for the statements, precision farming helps in application of nutrients based on crop requirements (67.11%), precision farming aims at precise management of weeds (67.11%), precision farming practices aims at precise management of pests (64.47%), precision farming helps to know the right time of application of inputs (64.47%) and precision farming aims at precise management of diseases (60.53%).

4.2.2 Compatibility

The perusal of the results in the Table 7 and Fig 12 pertaining to compatibility clearly shows that majority of the farmers 'strongly agree' with precision farming practices suits for all types of soils (77.63%) and for all types of crops (73.68%).

The results in the Table also indicated that, majority of the farmers 'agree' with, precision farming suits for all seasons (60.53%), suits to all improved cultivation practices (59.21%), to all agro climatic conditions (57.89%), to people of all education categories (57.89%), to all types of land holdings (56.58%). Further, half of the respondents (51.32%) disagreed that precision farming is economically compatible to all types of farmers.

4.2.3 Complexity

A cursory look at the results in Table 7 and Fig pertaining to complexity of precision farming revealed that majority of the farmers 'strongly agree' with precision 13 farming practices are difficult to adopt (75.00%), followed by difficult to analyse soil samples or handle costly equipments (60.53%), precision farming practices are difficult to understand (51.32%) and difficult to calculate grid wise nutrient requirement (48.68%). Whereas, 61.80 per cent of the farmers 'agree' with it is difficult to form the grids based on soil fertility and half of them (50.00%) agree to the statement that it is difficult to analyse moisture grid wise.

Percentage of farmers who 'disagree' to the statements were difficult to apply nutrient grid wise (51.32%), difficult to manage pest and diseases grid wise (42.11%) and difficult to work out cost benefit ratio or cost of cultivation (40.79%), respectively.

4.2.4 Trialability

A careful observation of the data presented in Table 7 and Fig 14 revealed that majority of the farmers 'strongly agree' with precision farming practices can be tried on all types of soils (76.32%) and on a small scale in any given situation (56.58%). Whereas majority of the farmers 'agree' with precision farming can be tried in all seasons (63.16%), application of nutrient based on soil analysis can be tried in a small scale (63.16%), can be tried by any category of farmers (59.21%), plant protection measures can be tried in small scale (56.58%), precision farming can be tried in all climatic conditions (55.26%), moisture analysis can be tried on small scale (53.95%) and formation of grids can be tried on small scale in precision farming (52.63%).

4.2.5 Observability

Perusal of Table 7 and Fig 15 revealed about the perception of observability of precision farming by farmers. Majority of the farmers 'strongly agree' with saving or optimum utilization of chemical fertilizers (68.42%), grid wise increase in yield (64.47%) and grid wise quality of the produce (51.32%) were evident in precision farming. Whereas majority of the farmers 'agree' with variability in weeds population (69.74%), grid wise moisture status (67.11%), grid wise crop condition (67.11%), grid wise soil fertility status (65.79%), variability in pest and disease population (60.53%), uniformity of crop maturity (56.58%) and grid wise cost benefit ratio (55.26%) can be observed in precision farming.

Table 7: Attribute wise perception of precision farming practices by the farmers

(n = 76)

Sl. No.	Perception statements	SA	A	UD	DA	SDA
		f (%)	f (%)	f (%)	f (%)	f (%)
I. Relative advantage						
1	Precision farming helps to apply nutrients based on soil variability	61 (80.26)	11 (14.47)	1 (1.32)	2 (2.63)	1 (1.32)
2	Application of nutrients based on soil variability results in balanced application of nutrients.	51 (67.11)	14 (18.42)	5 (6.58)	4 (5.26)	2 (2.63)
3	It helps in application of nutrients based on crop requirements.	14 (18.42)	51 (67.11)	3 (3.95)	5 (6.58)	3 (3.95)
4	Application of nutrients based on soil variability results increase nutrient use efficiency and there by increases net profit.	47 (61.84)	21 (27.63)	2 (2.63)	4 (5.26)	2 (2.63)
5	It aims at precise management of weeds.	15 (19.74)	51 (67.11)	3 (3.95)	4 (5.26)	3 (3.95)
6	It aims at precise management of pests.	13 (17.11)	49 (64.47)	5 (6.58)	5 (6.58)	4 (5.26)
7	It aims at precise management of diseases.	16 (21.05)	46 (60.53)	5 (6.58)	6 (7.89)	3 (3.95)
8	Timely management of cultivation practices increase quality of the produce.	39 (51.32)	19 (25.00)	6 (7.89)	7 (9.21)	5 (6.58)
9	It helps to know the right time of application of inputs.	12 (15.79)	49 (64.47)	4 (5.26)	7 (9.21)	4 (5.26)
10	Adoption of precision farming practices increases the yield.	52 (68.42)	13 (17.11)	5 (6.58)	4 (5.26)	2 (2.63)
II. Compatibility		SA	A	UD	DA	SDA
		f (%)	f (%)	f (%)	f (%)	f (%)
1	It suits for all the types of soils	59 (77.63)	12 (15.79)	2 (2.63)	2 (2.63)	1 (1.32)
2	It suits for all the types of land holdings	17 (22.37)	43 (56.58)	5 (6.58)	6 (7.89)	5 (6.58)
3	It suits for all the types of crops	56 (73.68)	14 (18.42)	3 (3.95)	2 (2.63)	1 (1.32)
4	It is suitable for all seasons	16 (21.05)	46 (60.53)	8 (10.53)	4 (5.26)	2 (2.63)
5	It is suitable for all agro climatic condition	15 (19.74)	44 (57.89)	9 (11.84)	5 (6.58)	3 (3.95)
6	It suits to all improved cultivation practices	18 (23.68)	45 (59.21)	7 (9.21)	4 (5.26)	2 (2.63)
7	It is economically compatible to all types of farmers	9 (11.84)	11 (14.47)	6 (7.89)	39 (51.32)	11 (14.47)
8	It is suitable for people of all education categories	19 (25.00)	44 (57.89)	5 (6.58)	5 (6.58)	3 (3.95)

Contd.....

III. Complexity		SA	A	UD	DA	SDA
		f (%)	f (%)	f (%)	f (%)	f (%)
1	Precision farming practices are difficult to understand	39 (51.32)	29 (38.20)	2 (2.63)	4 (5.26)	2 (2.63)
2	Difficult to analyse soil samples or handle costly equipments	46 (60.53)	24 (31.60)	2 (2.63)	3 (3.95)	1 (1.32)
3	Difficult to form the grids based on soil fertility analysis	19 (25.00)	47 (61.80)	3 (3.95)	5 (6.58)	2 (2.63)
4	Difficult to calculate grid wise nutrient requirement	37 (48.68)	18 (23.70)	5 (6.58)	10 (13.16)	6 (7.89)
5	Difficult to apply nutrient grid wise	9 (11.84)	13 (17.10)	4 (5.26)	39 (51.32)	11 (14.47)
6	Difficult to analyse moisture grid wise	23 (30.26)	38 (50.00)	5 (6.58)	9 (11.84)	1 (1.32)
7	Difficult to manage pest and diseases grid wise	11 (14.47)	14 (18.40)	6 (7.89)	32 (42.11)	13 (17.11)
8	Difficult to workout cost benefit ratio or cost of cultivation	12 (15.79)	16 (21.10)	8 (10.53)	31 (40.79)	9 (11.84)
9	Difficult in getting necessary inputs and other resources for practicing precision farming at small sized grids	37 (48.68)	15 (19.74)	7 (9.21)	11 (14.47)	6 (7.89)
10	Precision farming practices are difficult to adopt	57 (75.00)	12 (15.80)	2 (2.63)	3 (3.95)	2 (2.63)
IV. Trialability		SA	A	UD	DA	SDA
		f (%)	f (%)	f (%)	f (%)	f (%)
1	Precision farming practices can be tried on a small scale in any given situation	43 (56.58)	21 (27.63)	7 (9.21)	3 (3.95)	2 (2.63)
2	Precision farming practices can be tried by any category of farmers	14 (18.42)	45 (59.21)	5 (6.58)	7 (9.21)	5 (6.58)
3	Application of nutrient based on soil analysis can be tried in a small scale	16 (21.05)	48 (63.16)	6 (7.89)	4 (5.26)	2 (2.63)
4	Moisture analysis can be tried on small scale	17 (22.37)	41 (53.95)	9 (11.84)	5 (6.58)	4 (5.26)
5	It can be tried on all type of soils	58 (76.32)	13 (17.11)	2 (2.63)	2 (2.63)	1 (1.32)
6	It can be tried in all climatic conditions	15 (19.74)	42 (55.26)	10 (13.16)	6 (7.89)	3 (3.95)
7	It can be tried in all seasons	14 (18.42)	48 (63.16)	8 (10.53)	4 (5.26)	2 (2.63)
8	Plant protection measures can be tried in small scale	13 (17.11)	43 (56.58)	9 (11.84)	9 (11.84)	2 (2.63)
9	Formation of grids can be tried on small scale	17 (22.37)	40 (52.63)	5 (6.58)	10 (13.16)	4 (5.26)

Contd.....

V. Observability		SA	A	UD	DA	SDA
		f (%)	f (%)	f (%)	f (%)	f (%)
1	Grid wise soil fertility status can be observed	18 (23.68)	50 (65.79)	3 (3.95)	4 (5.26)	1 (1.32)
2	Grid wise moisture status can be observed	13 (17.11)	51 (67.11)	4 (5.26)	5 (6.58)	3 (3.95)
3	Variability in weeds population can be observed	15 (19.74)	53 (69.74)	3 (3.95)	3 (3.95)	2 (2.63)
4	Variability in pest and disease population can be observed	14 (18.42)	46 (60.53)	5 (6.58)	7 (9.21)	4 (5.26)
5	Savings or optimum utilization of chemical fertilizers can be observed	52 (68.42)	14 (18.42)	3 (3.95)	4 (5.26)	3 (3.95)
6	Grid wise crop condition can be observed	12 (15.79)	51 (67.11)	6 (7.89)	5 (6.58)	2 (2.63)
7	Grid wise quality of the produce can be observed	39 (51.32)	19 (25.00)	7 (9.21)	6 (7.89)	5 (6.58)
8	Uniformity of crop maturity can be observed	15 (19.74)	43 (56.58)	5 (6.58)	9 (11.84)	4 (5.26)
9	Grid wise increase in yield can be observed	49 (64.47)	14 (18.42)	6 (7.89)	4 (5.26)	3 (3.95)
10	Grid wise cost benefit ratio can be observed	17 (22.37)	42 (55.26)	8 (10.53)	5 (6.58)	4 (5.26)

f. – Frequency % - Percentage

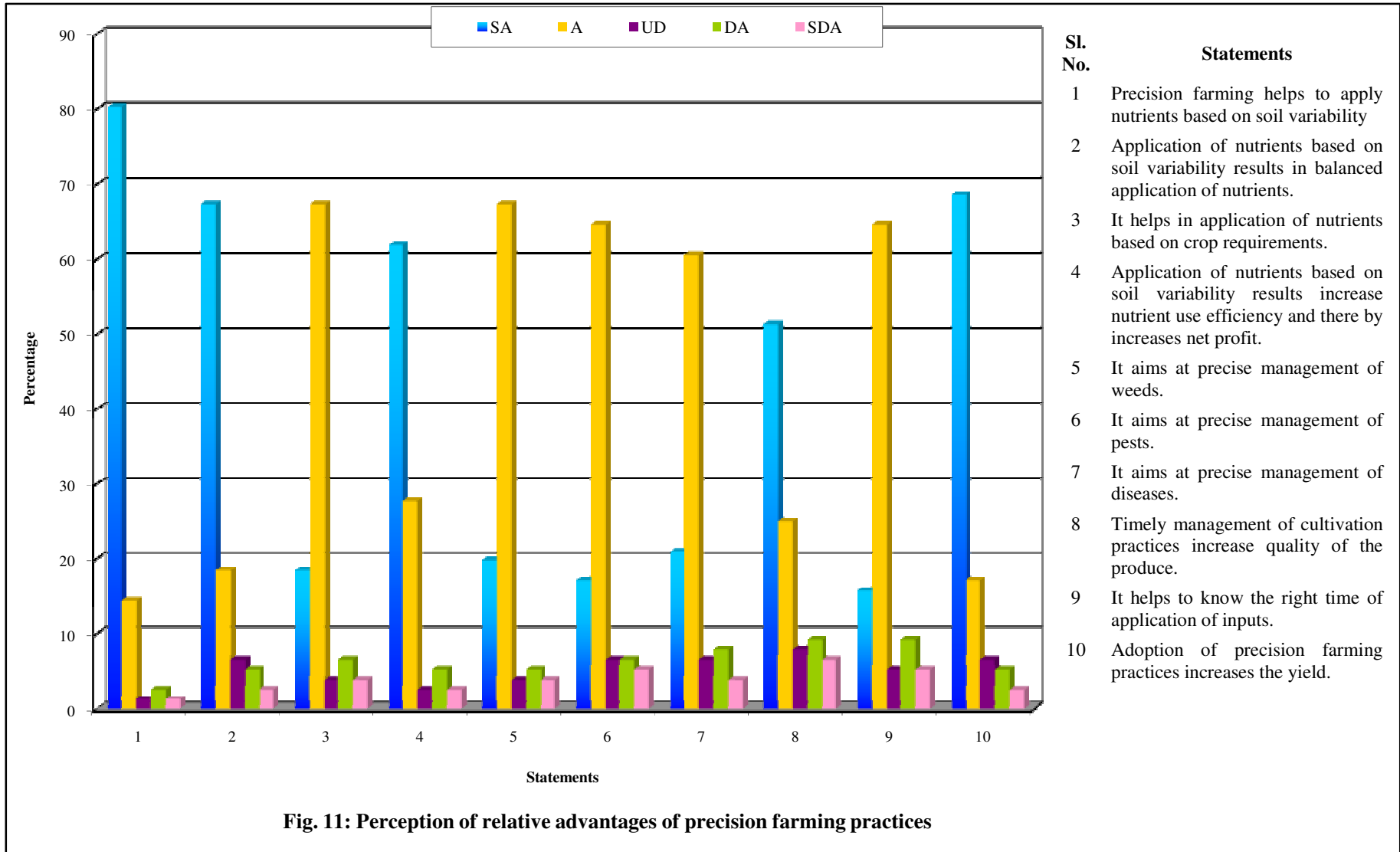
SA= Strongly agree

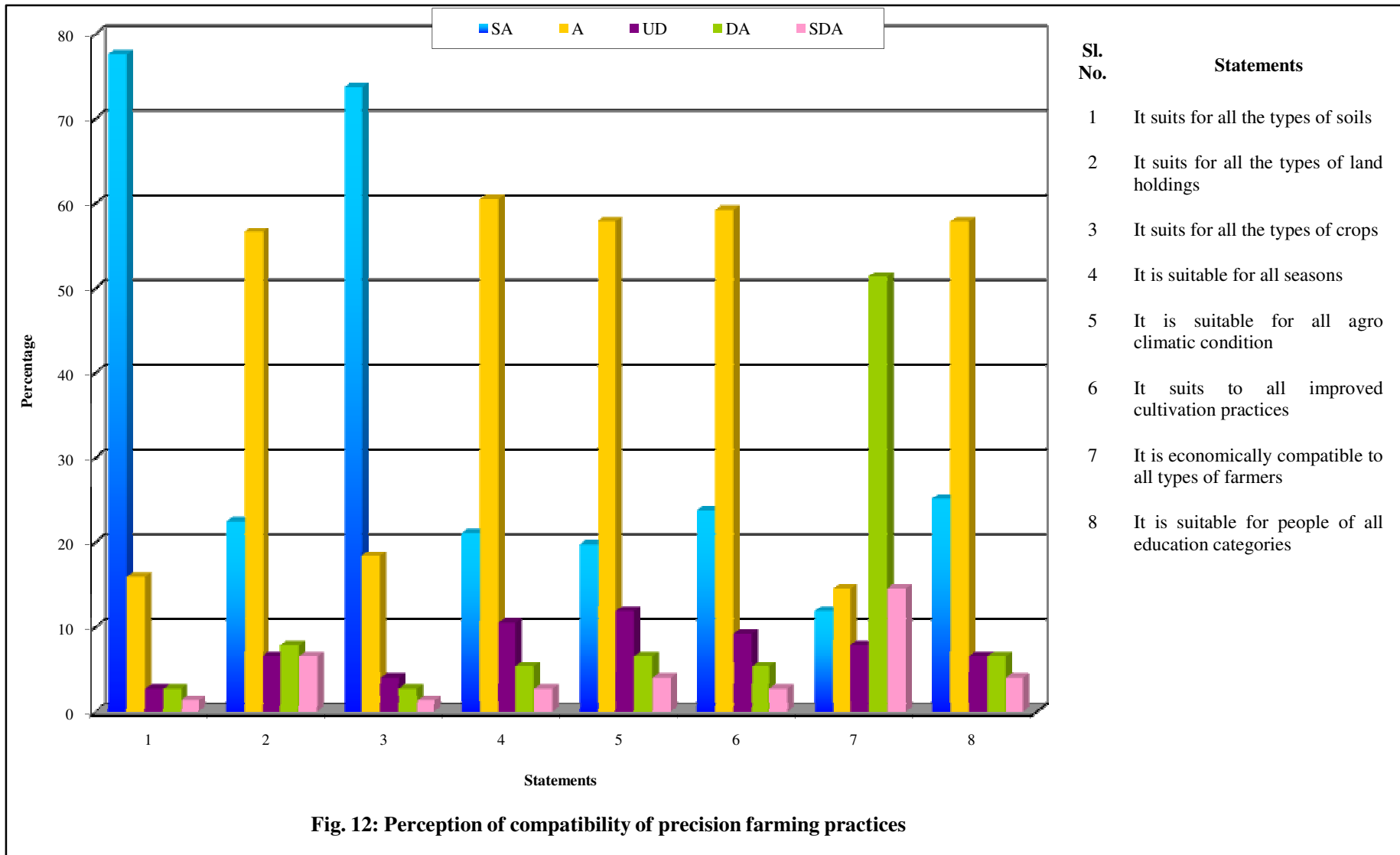
A=Agree

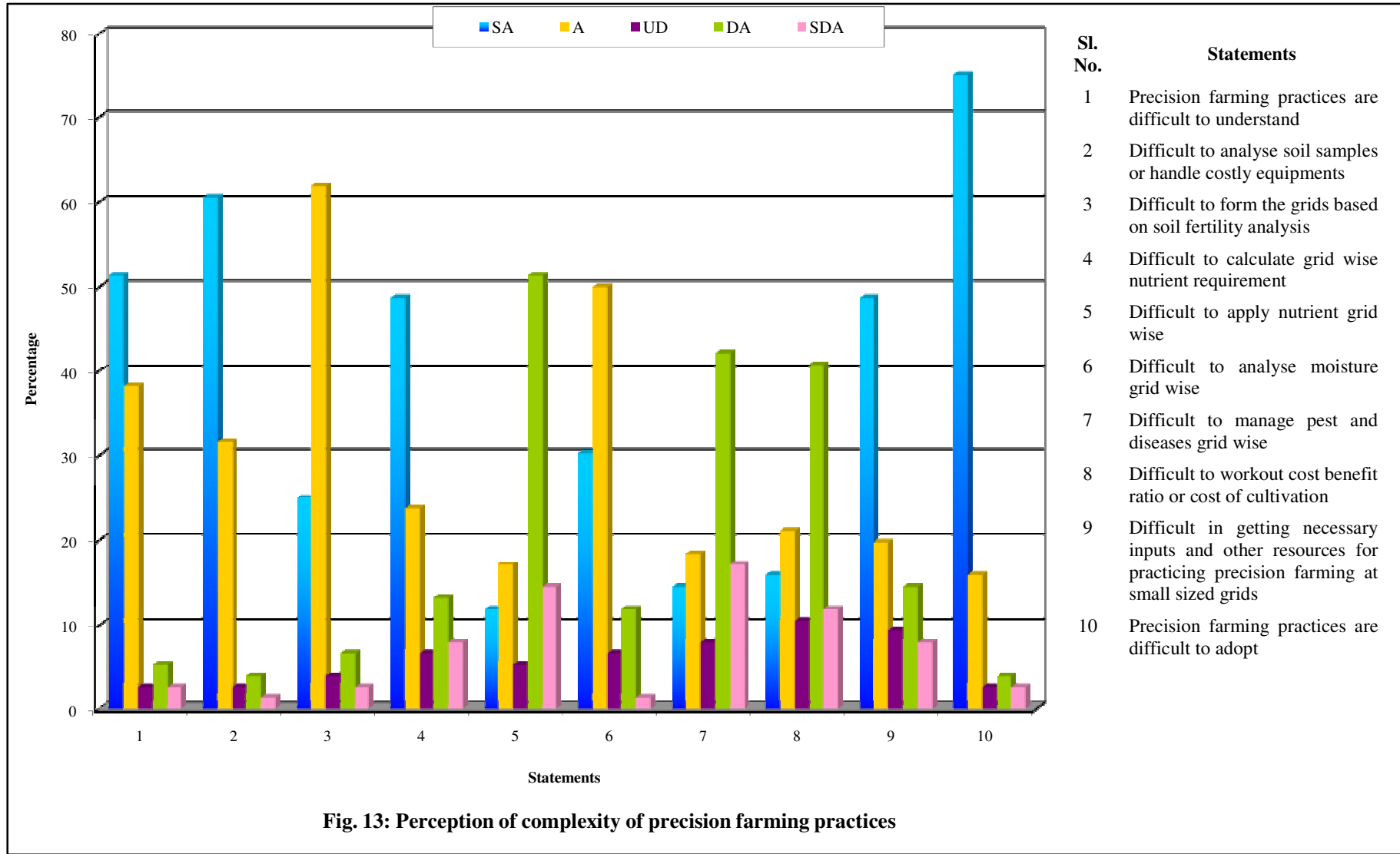
UD= Undecided

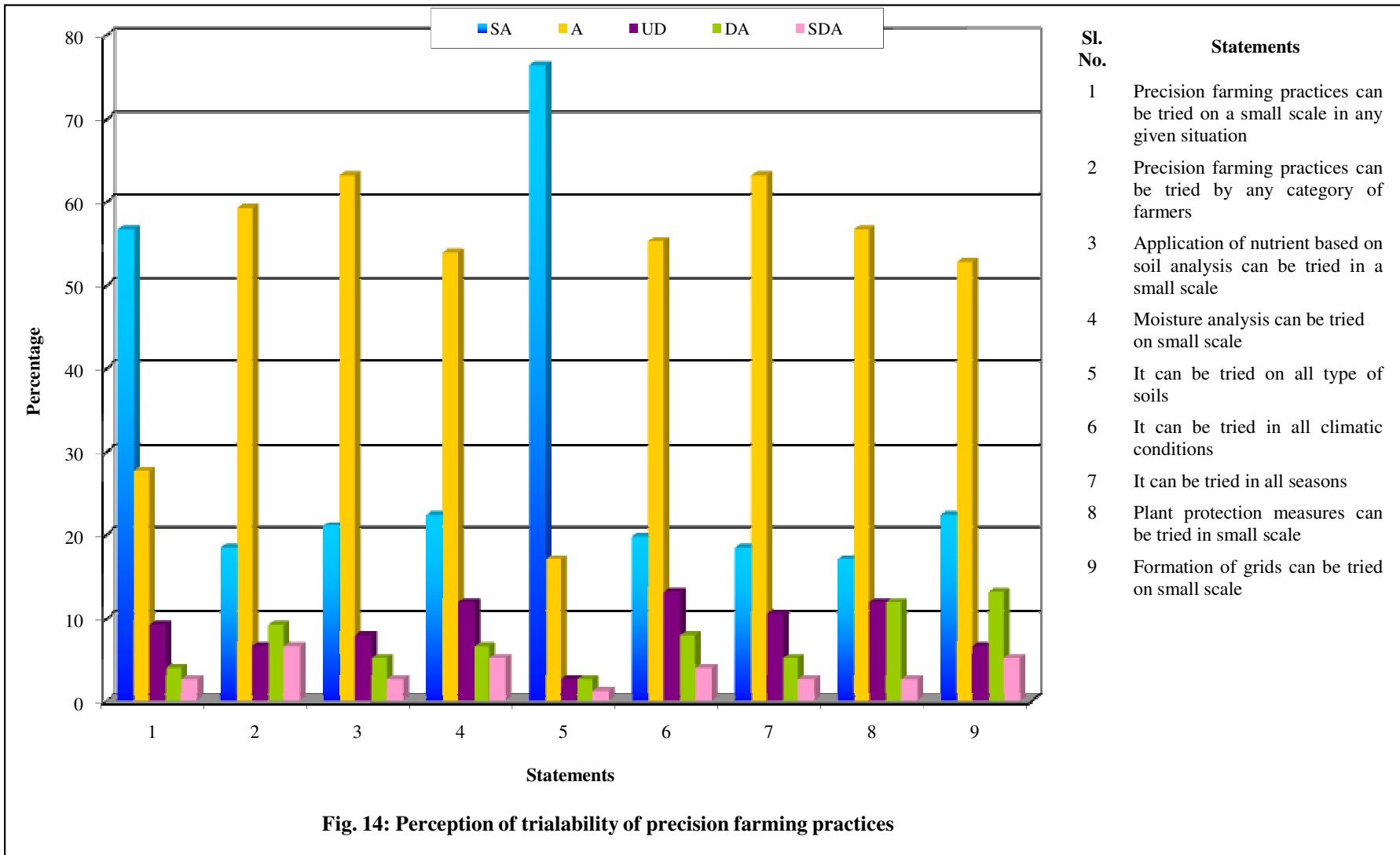
DA = Disagree

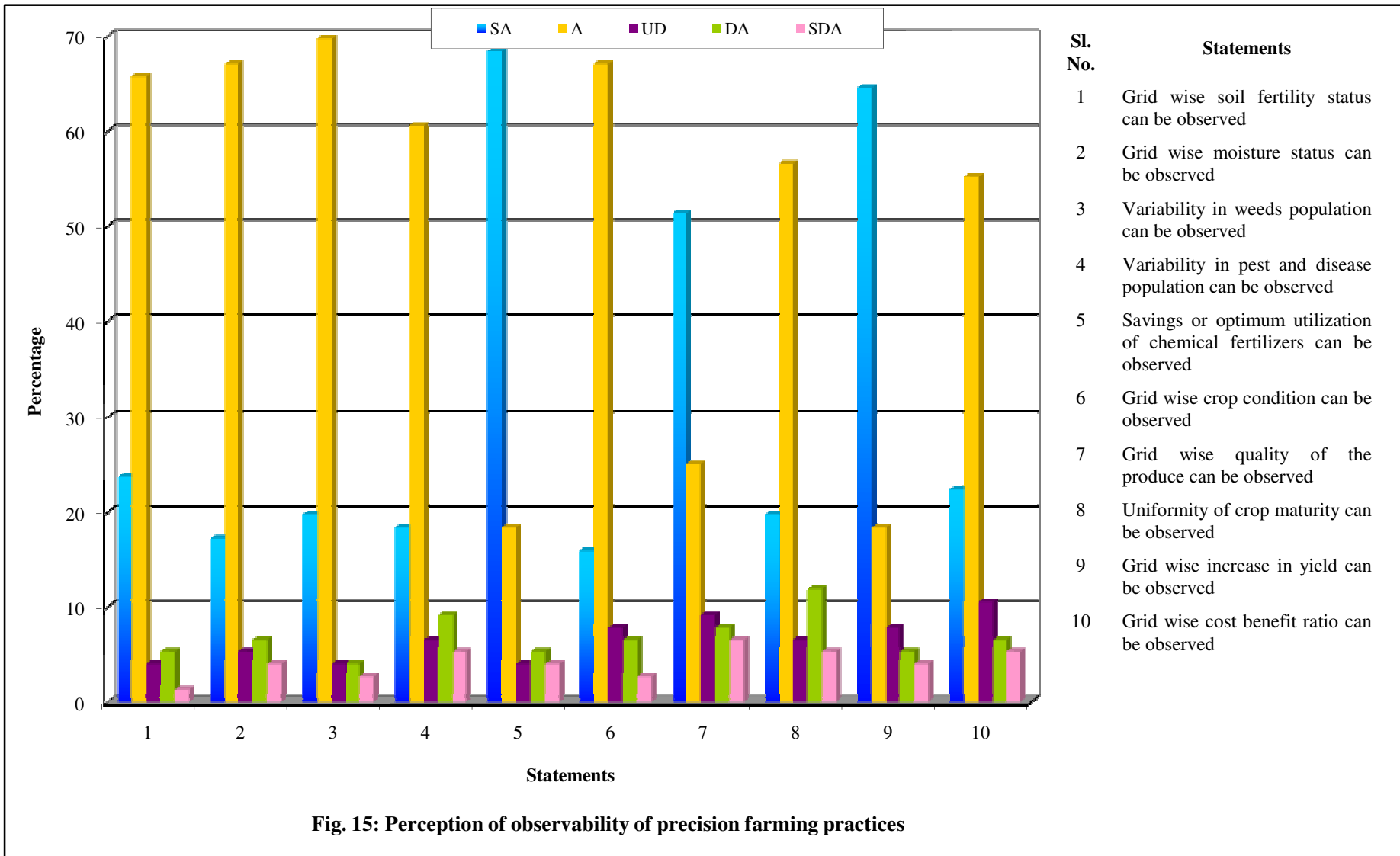
SDA= Strongly agree











4.3 Relationship between socio- economic characteristics of the farmers with their perception of precision farming

The zero order correlation was worked out between the level of perception of precision farming by the farmers and their various personal, socio-psychological and economic variables. Correlation was worked out for attribute wise as well as perception of precision farming as whole to know the pattern of relationship and the results to this effect are presented in Table 8.

4.3.1 Relationship between socio-economic characteristics of the farmer and perception of precision farming as whole

A perusal of results of correlation analysis presented in Table 8 and Fig 16 revealed that out of ten independent variables studied three variables namely extension contact, innovative proneness and crop productivity exhibited positive and significant relationship at one per cent level of probability with perception of precision farming. While, the variable mass media participation exhibited positively significant correlation at five per cent level of probability level with perception of precision farming by the farmers. On other hand material possession had negatively significant relationship with perception of precision farming at one per cent level of probability. The variables which did not show significant relationship were age, family size, education level, land holding and annual income.

4.3.2 Relationship between socio-economic characteristics of the farmers and attribute-wise perception of precision farming

It could be observed from Table 8 that out of ten characteristics studied to assess the relationship with perception of different attributes of precision farming practices, four variables namely extension contact, mass media participation, innovative proneness and crop productivity exhibited positive and significant relationship with all attributes of precision farming. Material possession exhibited negatively significant relationship with all the attributes of precision farming. Age, family size, education level land holding and annual income did not express significant relationship with perception of attributes of precision farming practices

4.4 Contribution of independent variables towards the perception of precision farming practices

4.4.1 Contribution of independent variables towards perception of precision farming as whole by the farmers

Multiple regression analysis was carried out to determine the extent of contribution made by the independent variables and to identify those variables which contribute significantly towards the variation in perception of precision farming by the farmers. The results of multiple regression analysis are presented in Table 9.

A careful observation of the data presented in Table 9 revealed that the 'F' value (10.455) obtained from the multiple regression analysis was found to be statistically significant at one per cent level indicating that all the independent variables put together exerted significant influence on the perception of precision farming by the farmers.

The co-efficient of determination (R^2) was 0.610 which revealed that 61.00 per cent of the variation in the perception of precision farming by the farmers was together explained by all the independent variables. Of the ten independent variables, only crop productivity contributed significantly towards influencing the perception of precision farming by the farmers.

4.4.2 Contribution of independent variables towards perception of attributes of precision farming by the farmers.

4.4.2.1 Contribution of independent variables towards perception of relative advantages of precision farming by the farmers

The results of multiple regression analysis are presented in Table 10. It could be observed from the results that 'F' value (8.910) obtained was significant at one per cent level indicating that all the independent variables put together contributed significantly to the variation in the perception of relative advantages of precision farming by the farmers. The co-efficient of determination (R^2) was 0.578 which revealed that 57.80 per cent of the variation in the perception of relative advantage of

Table 8: Zero order correlation of independent variables with perception of precision farming

(n = 76)

Independent variables	Correlation Coefficients (r values)					
	Relative advantage	Compatibility	Complexity	Triability	Observability	Perception as whole
Age	0.152	0.134	0.099	0.172	0.152	0.142
Family size	0.053	0.089	0.207	0.078	0.082	0.106
Educational level	-0.038	-0.102	-0.051	-0.056	-0.053	-0.058
Land holding	0.078	0.091	0.204	0.091	0.088	0.115
Annual income	-0.062	-0.043	0.068	-0.037	-0.059	-0.024
Extension contact	0.590**	0.650**	0.647**	0.623**	0.611**	0.631**
Mass media participation	0.235*	0.256*	0.247*	0.232*	0.242*	0.264*
Innovative proneness	0.380**	0.358**	0.260*	0.369**	0.257*	0.398**
Crop productivity	0.605**	0.647**	0.768**	0.629**	0.621**	0.665**
Material possession	-0.645**	-0.672**	-0.730**	-0.680**	-0.666**	-0.689**

*. Correlation is significant at the 0.05 level

** . Correlation is significant at the 0.01 level

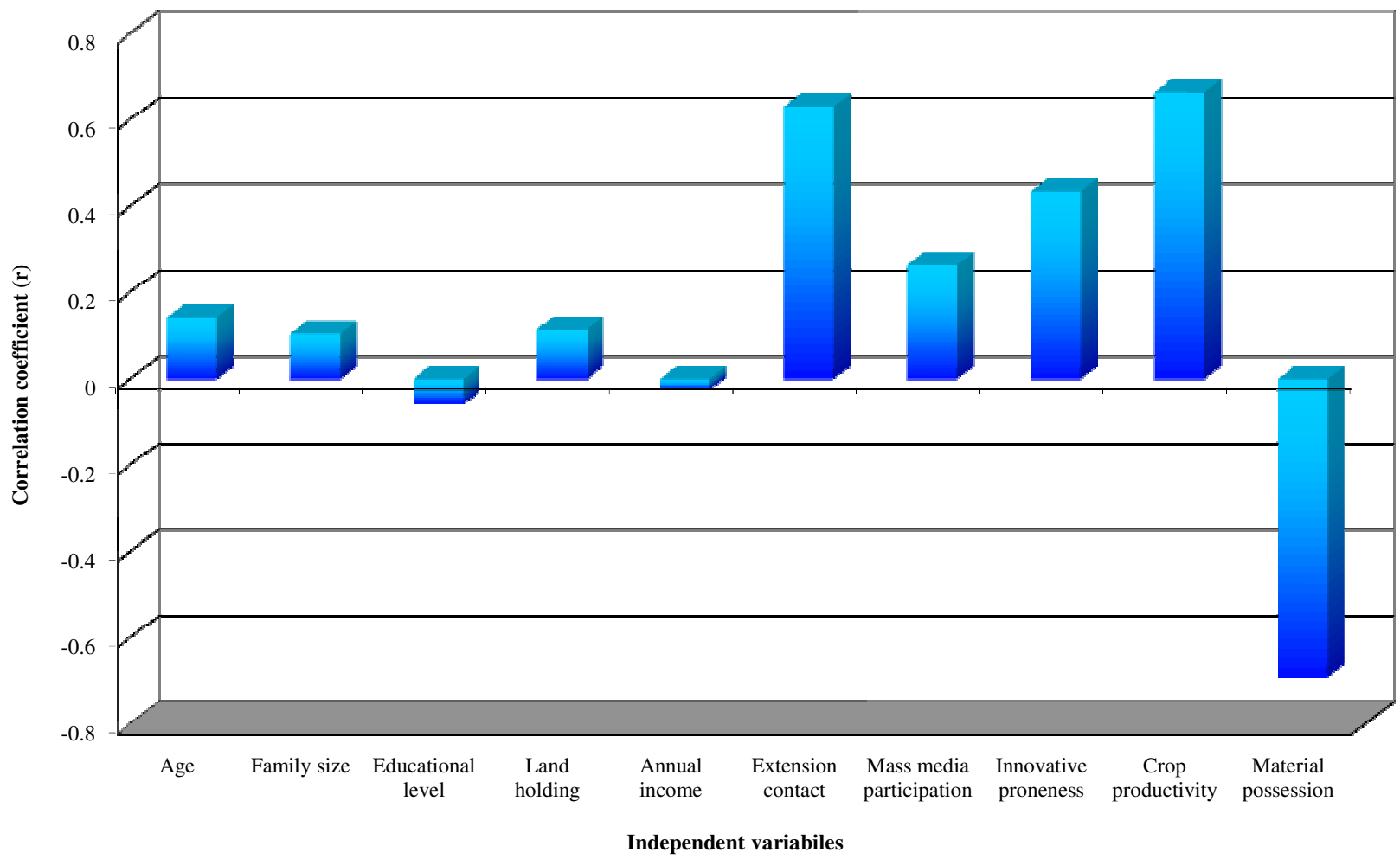


Fig. 16: Zero order correlation of independent variables with perception of preision farming as whole

Table 9: Multiple regression analysis of the independent variables with perception of precision farming as whole by the farmers

Variables	Regression coefficient (b)	Standard error	't' value
Constant	64.004	53.354	2.69
Age	0.835	0.508	1.643
Family size	0.123	1.300	0.095
Education	0.547	0.922	0.593
Annual income	-5.065E-5	0.000	1.954
Land holding	-0.072	0.304	-0.237
Innovative proneness	3.061	1.427	2.145
Crop productivity	1.125	0.159	7.059**
Extension contact	-1.595	1.719	0.928
Mass media participation	-1.490	1.476	1.009
Material possession	1.187	0.767	1.547

$R^2 = 0.616$ $F = 10.455^{**}$
 ** = significant at the 0.01 level

Table 10: Multiple regression analysis of the independent variables with perception of relative advantages precision farming by the farmers

(n = 76)

Variables	Regression coefficient (b)	Standard error	't' value
Constant	30.477	10.135	3.006
Age	0.185	0.114	1.628
Family size	-0.040	0.290	0.139
Education	0.185	0.206	0.900
Annual income	-1.129E-5	0.000	1.949
Land holding	-0.011	0.068	0.156
Innovative proneness	0.750	0.321	2.330
Crop productivity	0.215	0.036	6.045**
Extension contact	-0.390	0.384	1.014
Mass media participation	-0.317	0.330	0.961
Material possession	0.317	0.172	1.847

$R^2 = 0.578$

$F = 8.910^{**}$

** = significant at the 0.01 level

precision farming by the farmers was explained by all the independent variables selected for the study.

The results also revealed that among ten independent variables only crop productivity was found to be significant at one per cent level in influencing perception of relative advantages of precision farming by the farmers.

4.4.2.2 Contribution of independent variables towards perception of compatibility of precision farming by the farmers

The relationship of independent variables with the perception of compatibility of precision farming by the farmers was studied through multiple regression analysis and the results on this aspect are presented in Table 11. A cursory glance of the results reveals that among ten independent variables, only crop productivity was significantly influencing the perception of compatibility of precision farming by the farmers at one per cent level. The 'F' value (8.990) was found to be significant at one per cent level and co-efficient of determination was 0.580, which revealed that 58.00 per cent of the variation in the perception of compatibility of precision farming by the farmers was explained by all the ten variables included in the study.

4.4.2.3 Contribution of independent variables towards perception of complexity of precision farming by the farmers

The results of the multiple regression analysis are presented in Table 12. The independent variable crop productivity was found to be positively significant at one per cent level of probability in influencing the perception of complexity of precision farming by the farmers. The 'F' value (15.944) was found to be significant at one per cent level and co-efficient of determination was 0.710 which revealed that 71.00 per cent of the variation in the perception of complexity of precision farming by the farmers was explained by all the independent variables selected in the study.

4.4.2.4 Contribution of independent variables towards perception of trialability of precision farming by the farmers.

A careful observation of the data presented in Table 13 revealed that the 'F' value (8.766) obtained from the multiple regression analysis was found to be statistically significant at one per cent level indicating that all the independent variables put together exerted significant influence on the perception of trialability of precision farming by the farmers. The co-efficient of determination (R^2) was 0.574 which revealed that 57.40 per cent of the variation in the perception of trialability of precision farming by the farmers was together explained by all the independent variables.

Of the ten independent variables, only crop productivity contributed significantly at one per cent level probability towards the variation in the perception of trialability of precision farming by the farmers.

4.4.2.5 Contribution of independent variables towards perception of observability of precision farming by the farmers

The 'F' value (9.270) obtained was significant at one per cent level indicating that all the independent variables put together contributed significantly to the variation in the perception of observability of precision farming by the farmers (Table 14). The co-efficient of determination (R^2) was 0.588 which revealed that 58.80 per cent of the variation in the perception of observability of precision farming by the farmers was explained by all the variables selected for the study. Of the ten variables, only crop productivity contributed significantly towards the variation in the perception of observability of precision farming by the farmers.

4.5 Impact of precision farming practices on crop productivity and income of the farmers

4.5.1 Impact of precision farming practices on crop productivity of the farmers

The results presented in Table 15 indicated the impact of precision farming practices on productivity of the farmers with respect to sugarcane, cotton and chilli.

The average yield of sugarcane crop before adoption of precision farming was 43.80 t/ac whereas the average yield after the adoption of precision farming was 51.60 t/ac indicating 7.80 t/ac increases. The percentage increase in average yield was found to be their 17.80. Further, the difference in average yield of sugarcane growers before and after the adoption of precision farming

Table 11: Multiple regression analysis of the independent variables with perception of compatibility of precision farming by the farmers

(n = 76)

Variables	Regression coefficient (b)	Standard error	't' value
Constant	23.84	7.590	3.133
Age	0.105	0.084	1.246
Family size	0.011	0.216	0.052
Education	0.001	0.153	0.009
Annual income	-8.032E-6	0.000	1.864
Land holding	-0.017	0.051	0.333
Innovative proneness	0.326	0.240	1.352
Crop productivity	0.181	0.026	6.843**
Extension contact	-0.334	0.286	1.170
Mass media participation	-0.249	0.245	1.015
Material possession	0.179	0.128	1.406

$R^2 = 0.580$

$F = 8.990^{**}$

** = significant at the 0.01 level

Table 12: Multiple regression analysis of the independent variables with perception of complexity of precision farming by the farmers

(n = 76)

Variables	Regression coefficient (b)	Standard error	't' value
Constant	26.240	9.050	2.894
Age	0.163	0.105	1.551
Family size	0.102	0.268	0.380
Education	0.067	0.190	0.353
Annual income	-1.036E-5	0.000	1.933
Land holding	-0.012	0.063	0.188
Innovative proneness	0.738	0.287	2.572
Crop productivity	0.302	0.033	9.158**
Extension contact	-0.126	0.355	0.355
Mass media participation	-0.323	0.305	1.058
Material possession	0.201	0.159	1.266

$R^2 = 0.710$

$F = 15.944^{**}$

** = significant at the 0.01 level

Table 13: Multiple regression analysis of the independent variables with perception of trailability of precision farming by the framers

(n = 76)

Variables	Regression coefficient (b)	Standard error	't' value
Constant	23.550	8.963	2.627
Age	0.196	0.100	1.952
Family size	0.000	0.257	0.003
Education	0.146	0.182	0.803
Annual income	-8.732E-6	0.000	1.706
Land holding	-0.025	0.060	0.418
Innovative proneness	0.504	0.284	1.773
Crop productivity	0.206	0.031	6.539**
Extension contact	-0.348	0.339	1.024
Mass media participation	-0.260	0.291	0.891
Material possession	0.216	0.152	1.422

$R^2 = 0.574$

$F = 8.766^{**}$

** = significant at the 0.01 level

Table 14: Multiple regression analysis of the independent variables with perception of observability of precision farming by farmers

(n = 76)

Variables	Regression coefficient (b)	Standard error	't' value
Constant	29.880	10.079	2.964
Age	0.186	0.113	1.647
Family size	0.051	0.289	0.177
Education	0.146	0.205	0.714
Annual income	-1.224E-5	0.000	2.121*
Land holding	-0.008	0.068	-0.114
Innovative proneness	0.741	0.319	2.323
Crop productivity	0.221	0.035	6.232**
Extension contact	-0.398	0.383	1.040
Mass media participation	-0.341	0.329	1.039
Material possession	0.275	0.171	1.608

$R^2 = 0.588$

$F = 9.270^{**}$

** = significant at the 0.01 level

practices was significant at one per cent level of probability as revealed by 't' values. The average yields of cotton crop before and after the adoption of precision farming practices were 9.10 q/ac and 12.40 q/ac, respectively with an increase of 3.30 q/ac. The percentage increase in average yield was found to be 36.26. The increase in average yield of cotton before and after the adoption of precision farming practices was significant at one per cent level of probability as revealed by 't' values.

The average yield of chilli crop before and after the adoption of precision farming practices were 4.60 q/ac and 5.80 q/ac, respectively, with an increase of 1.30 q/ac. The percentage increase in average yield was found to be 26.08. The increase in average yield of chilli before and after the adoption of precision farming practices was significant at one per cent level of probability as revealed by 't' values.

4.5.2 Impact of precision farming on income of the farmers

The data in the Table 16 revealed that, the average per acre income of the sugarcane growers before adoption of precision farming was Rs. 55480/- whereas after adoption of precision farming was Rs. 69080/- with an increase of Rs. 13600/-. The per cent change in income was found to be 24.51 per cent. Further, the increase in average per acre income of sugar cane growers before and after the adoption of precision farming practices was highly significant at one per cent level of probability as revealed by 't' test.

The average per acre income of the cotton growers before adoption of precision farming was Rs. 16877/- whereas after adoption of precision farming was Rs. 29642/- with an increase of Rs. 12765/-. The per cent change in income was found to be 75.63

Further, the difference in average per acre income of cotton growers before and after the adoption of precision farming practices was highly significant at one per cent level of probability as revealed by 't' test.

The data in the Table 16 also revealed that, the average per acre income of the chilli growers before adoption of precision farming was Rs. 44880/- whereas after adoption of precision farming was Rs. 58181/- with an increase of Rs. 13301/-. The per cent change in per acre income was found to be 29.63. Further, the increase in average per acre income of chilli growers before and after the adoption of precision farming practices was highly significant at one per cent level of probability as revealed by 't' test.

4.6 Constraints faced by the farmers in the adoption of precision farming practices

It was evident from the Table 17 and Fig 17 that high initial cost (96.05%) was emerged as most important constraint faced by the farmers in adoption of precision farming followed by difficulty in formation grids in fields (93.42%), difficulty in the soil variability analysis (92.11%), difficulty in identifying the pest and diseases grid wise (88.16%), difficulty to take plant protection measures grid wise (86.64%), difficulty to apply nutrients based on soil variability analysis (85.53%), lack of knowledge about precision farming technologies (84.21%) and non -availability of required inputs (78.95%). Lack of local technical expertise (59.21%), lack of finance and credit facility (48.68%), inadequate training and demonstrations (46.05%), lack of remunerative prices based on quality of produce (43.42%), lack of skilled labour to operate and handle the equipments (40.78%), small size of landholdings for adoption of precision farming (31.58%) and heterogeneity of cropping system (28.95%) were the other constraints faced by the farmers in adoption of precision farming practices.

Table 15: Impact of precision farming practices on crop productivity

(n = 76)

Crops	Average Yield		Difference in yield	%	t value
	Before Precision farming	After Precision farming			
Sugar cane (t/ac)	43.80	51.60	7.80	17.80	12.233**
Cotton (q/ac)	9.10	12.40	3.30	36.26	4.318**
Chilli (q/ac)	4.60	5.80	1.20	26.08	3.130**

%= Percentage

** significant at 0.01%

Table 16: Impact of precision farming practices on income of farmers

(n = 76)

Crops	Average Income		Difference in income	%	t value
	Before Precision farming	After Precision farming			
Sugar cane (Rs)	55480	69080	13600	24.51	15.627**
Cotton (Rs)	16877	29642	12765	75.63	10.365**
Chilli (Rs)	44880	58181	13301	29.63	6.057**

%= Percentage

** significant at 0.01%

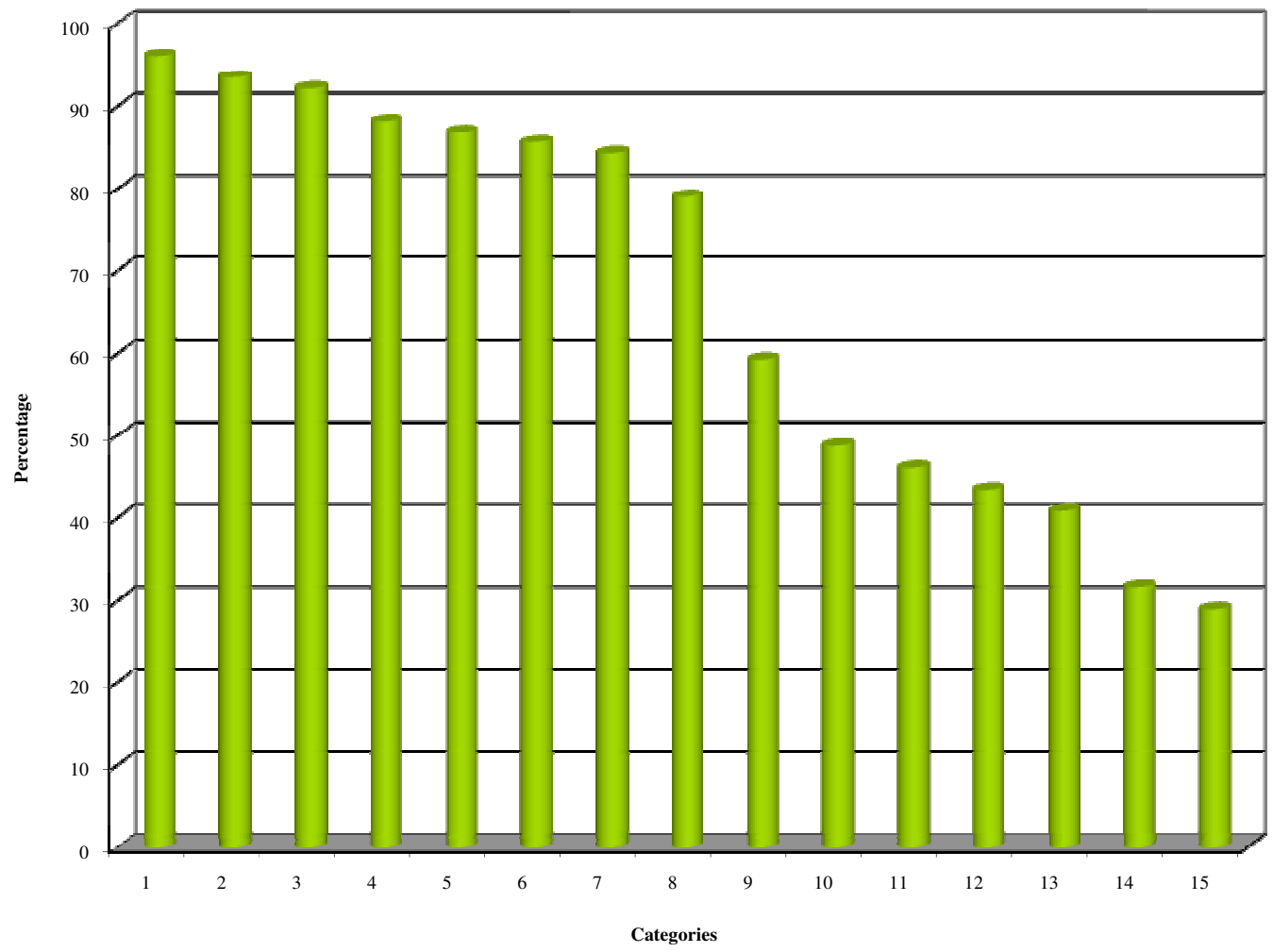
Table 17: Constraints faced b the farmers in adoption of precision farming practices

(n = 76)

Sl. No.	Constraints	f	%
1	High initial cost	73	96.05
2	Difficulty in formation of grids based on soil variability.	71	93.42
3	Difficulty in the soil variability analysis	70	92.11
4	Difficulty in identifying the pest and diseases grid wise.	67	88.16
5	Difficulty to take plant protection measures grid wise.	66	86.84
6	Difficulty to apply nutrients based on soil variability analysis.	65	85.53
7	Lack of knowledge about precision farming technologies	64	84.21
8	Non -availability of required inputs.	60	78.95
9	Lack of local technical expertise	45	59.21
10	Lack of finance and credit facility	37	48.68
11	Inadequate training and demonstrations	35	46.05
12	Lack of remunerative prices based on quality of produce	33	43.42
13	Lack of skilled labour to operate and handle the equipments	31	40.78
14	Small size of landholdings for adoption of precision farming.	24	31.58
15	Heterogeneity of cropping system.	22	28.95

f – Frequency

% - Percentage



- | Sl. No. | Constraints |
|---------|---|
| 1 | High initial cost |
| 2 | Difficulty in formation of grids based on soil variability. |
| 3 | Difficulty in the soil variability analysis |
| 4 | Difficulty in identifying the pest and diseases grid wise. |
| 5 | Difficulty to take plant protection measures grid wise. |
| 6 | Difficulty to apply nutrients based on soil variability analysis. |
| 7 | Lack of knowledge about precision farming technologies. |
| 8 | Non -availability of required inputs. |
| 9 | Lack of local technical expertise. |
| 10 | Lack of finance and credit facility |
| 11 | Inadequate training and demonstrations |
| 12 | Lack of remunerative prices based on quality of produce |
| 13 | Lack of skilled labour to operate and handle the equipments |
| 14 | Small size of landholdings for adoption of precision farming. |
| 15 | Heterogeneity of cropping system. |

Fig. 17: Constraints faced by the farmers in adoption of precision farming practices

DISCUSSION

The results of the study are discussed in this chapter under the following headings.

- 5.1 Profile of the farmers
- 5.2 Perception of precision farming practices by the farmers
- 5.3 Relationship of independent variables with perception of precision farming by the farmers
- 5.4 Impact of precision farming on crop productivity and income of farmers
- 5.5 Constraints faced by precision farming farmers in the adoption of precision farming practices

5.1 Profile of the farmers

5.1.1 Age

An overview of the Table 1 and Fig 2 revealed that majority (60.53%) of the farmers belonged to middle age category followed by old age category (26.32%) and young age (13.15%) category. It can be inferred from the above results that most of middle age farmers were the key generators of income which occupy the main work force in different occupations. Further middle aged people have physical vigour, enthusiasm, more farming experience, more sense of responsibility and were more involved in the farming occupations. It could also be that young generation is less interested in agriculture and were more attracted to non farm occupations. It could also be due to the fact that parents might be encouraging the children to go for higher education and to take up nonfarm occupation.

The studies of Rakesh (2010), Priya (2011) and Huded (2013), who delineated the dominance of middle age among the sample farmers were in agreement with the present findings.

5.1.2 Education level

An insight into Table 1 and Fig 2 revealed that 25.00 per cent of the farmers had high school level education followed by 22.37 per cent educated upto PUC level, 14.47 per cent educated upto graduation and 13.16 per cent educated upto middle school. A meager (7.89%) per cent of the farmers had primary school education. A considerable per cent (17.11%) of farmers were illiterate.

In general, results shows that most of the farmer had fair amount of formal education. The inclination to education has been increasing in general and more in rural areas. The education generally empowers the human being not only to understand the situation but also make aware of problems and solutions to get out of the deprived situation. The government policy of free education upto high school might be another reason for fair amount of education. The results were in line with the findings of the studies reported by Satish (2010) and Huded (2013).

5.1.3 Family size

It is evident from the data in Table 1 and Fig 2 that more than half (55.26%) of the farmers belonged to medium size family, more than one fourth (26.32%) of farmers belonged to small size family and little less than one fifth (18.42%) of the farmers belonged to big size family. Agriculture is the main occupation of sample farmers that requires active participation of more number of family members. In study area majority of the farmers were growing commercial crops like cotton, sugarcane, chilli *etc.* which requires more manpower. Hence many of the respondents might have opted for medium size families. The results were in line with the findings of the studies reported by Raghunandan (2004).

5.1.4 Land holding

It is learnt from Table 1 and Fig 2 that more than two fifth of the farmers belonged to medium land holding (40.79%) category followed by big land holding (30.26%) and semi medium land holding (18.42%) category. A meager per cent of farmers belonged to small land holding (7.90%) and marginal land holding (2.63%) category. It is clear from results of family size that more than half (55.26%) of the farmers belonged medium size family and some of the farmers had access to irrigation facilities. An application of conversion factor of one acre of irrigated land equivalent to 3 acres of dry land led to increases in size of land holding. This could be the reasons for the majority of the farmers belonged to medium and big land holding category.

The findings were in conformity with the results of Satish (2010).

5.1.5 Annual income

The results on economic status of the farmers in Table 1 and Fig 2 revealed that 72.37 per cent of farmers belonged to high income category followed medium (17.11%) and low income (10.53%) category. The possible reason might be that majority of the farmers belonged to medium and large size land holding coupled with cultivation of commercial crops like Bt cotton, sugarcane, chilli, turmeric, maize, etc in *kharif* and *rabi* seasons. The findings of the study are supported by the studies of Satish (2010) and Priya (2011).

5.1.6 Mass media participation

It is evident from the data in Table 2 and Fig 3 that 53.95 per cent of the farmers were found in medium to high level of mass media participation. This indicates that mass media like television, radio, news paper and farm magazine were utilized by majority of the farmers. It might be due to high educational level and sound economic status of the farmers.

The results pertaining to mass media participation presented in Table 2 revealed that television was the most effective common medium which was possessed by a large majority of the farmers (96.05%), because of its strong audio visual impact on viewers. The results revealed that radio was possessed by 30.26 per cent of the farmers. A common man easily affords to possess radio. Moreover, these two media overcome the barrier of illiteracy.

The television viewing and radio listening were used mainly for the purposes other than agricultural programmes. Reasons for this might be two pronged. One could be that after tedious work in the field farmers might be made inclined to view/listen light entertainment programmes. Other could be that agriculture programme might not be giving relevant and practical information derived by them. The results were in agreement with the findings of Manjunath (2011).

5.1.7 Extension contact

An over view of Table 3.1 and Fig 6 revealed that more than two fifth of the farmers (42.10%) had medium extension contact followed high (34.22%) and low (23.68%) level of extension contact. This results might be due to different subsidy provided under various agricultural development programmes, encouraging farmers be in touch with the extension official to avail various benefits. The studies were supported by the findings of Rakesh (2010) and Satish (2010).

5.1.8 Innovative proneness

The results presented in Table 4 and Fig 7 revealed that, 51.32 per cent of farmers had medium level of innovative proneness, while 26.31 and 23.37 per cent of farmers had high and low level of innovative proneness categories, respectively. Innovative proneness is a cognitive aspect of change, which affects the readiness of an individual to accept new technology. Majority of the farmers possessed medium to big land holdings and hence they would like to obtain higher returns by adopting the innovations.

The research study of Shashidhara (2003) and Huded (2013) also reported the existence of medium innovative proneness to support the present findings.

5.1.9 Material possession

The data in Table 5 and Fig 8 revealed that, majority of farmers possessed knapsack sprayer (92.10%), seed drill (88.15%), harrow (84.21%), wooden plough (80.26%), cultivators (61.84%), tractor (56.57%) and see-cum-fertilizer drill (52.63%). These are necessary equipment to carry out important farming activities like ploughing, harrowing and sowing purpose. The other reason could be due to better economic conditions of the farmers, large land holding and reduced dependence on labour which has become scarce now a days. The possession of necessary materials also helps to take timely agricultural operations. The findings were in conformity with the results of Jyoti (2012).

5.1.10 Crop productivity

The data in Table 6 and Fig 10 revealed that, the average productivity of the sugar cane was 42.30 t/ac followed by maize (25.10 q/ac), turmeric (24.24 q/ac), wheat (6.78 q/ac), cotton (8.13 q/ac), soyabean (7.68 q/ac), chilli (4.04 q/ac) and groundnut (6.60 q/ac). Further majority of sugarcane (58.06%), maize (66.15%), turmeric (58.82%), wheat (54.16%) and soyabean (76.00%) growers

obtained the yields above average productivity. Higher productivity in sugarcane could be attributed to various factors like practice of precision farming, use of improved varieties, adoption of recommended practices and access to irrigation facilities. The findings were in conformity with the results of Savita (2008) and Anil (2013).

5.2 Attribute-wise perception of precision farming practices by the farmers

The results pertaining to perception of various attributes precision farming practices are discussed below.

5.2.1 Relative advantage

The results in the Table 7 and Fig 11 pertaining to relative advantage indicated that majority of the farmers strongly agree with precision farming helps to apply nutrients based on soil variability (80.26%). Adoption of precision farming practices increases the yield was strongly agreed by 68.42 per cent, which was followed by application of nutrients based on soil variability results in balanced application of nutrients (67.11%), application of nutrients based on soil variability results increase nutrient use efficiency and there by increases net profit (61.84%) and timely management of cultivation practices increase quality of the produce (51.32%).

The Table also revealed that majority of the farmers agree for the statements, precision farming helps in application of nutrients based on crop requirements (67.11%), precision farming aims at precise management of weeds (67.11%), precision farming practices aims at precise management of pests (64.47%), precision farming helps to know the right time of application of inputs (64.47%) and precision farming aims at precise management of diseases (60.53%).

Precision farming demands application of chemical fertilizers and micronutrients based on soil variability and crop requirement at different stages. The timely pest and disease and weed control measures are also taken up grid wise depending upon incidence. These contribute for increased yield levels, increased quality of produce, effective control of pest and diseases, effective and timely management of weeds, reduced application of chemical fertilizers and micro nutrients and reduced the use of chemicals to control the pest and diseases. These might be the reasons for majority of the farmers 'agree' with the all relative advantages of precision farming practices. The findings were in conformity with the results of Mankar (1998), Karthik and Manjunath (2011) and Rathakrishnan (2012).

5.2.2 Compatibility

The perusal of the results in the Table 7 and Fig 12 pertaining to compatibility clearly shows majority of the farmers 'strongly agree' with precision farming practices suits for all types of soils (77.63%) and for all types of crops (73.68%).

The results in the Table also indicated that, majority of the farmers 'agree' with, precision farming suits for all seasons (60.53%), suits to all improved cultivation practices (59.21%), to all agro climatic conditions (57.89%), to people of all education categories (57.89%), to all types of land holdings (56.58%). Further half of the respondents (51.32%) disagreed that precision farming is economically compatible to all types of farmers.

The successful adoption of any improved practice depends upon how compatible it is with users bio physical and socio cultural environment. As per the study precision farming can be adopted in all types of soils, all types of land holding, all types of crops, all seasons, all agro-climatic conditions, all improved cultivation practices and farmers of all education category. These might be the reasons for majority of the farmers 'agree' with compatibility attributes of precision farming practices.

On the other hand, the precision farming practices such as soil testing, soil moisture analysis, application of chemical fertilizers and micronutrients grid wise involves additional expenditure and demand time on the part of farmers. These might be the reasons for majority of the farmers 'disagree' with precision farming is economically compatible to all types of farmers. The studies were supported by the findings of Mankar (1998), Savitha (2011) and Rathakrishnan (2012).

5.2.3 Complexity

A cursory look at the results in Table 7 and Fig 13 pertaining to complexity of precision farming revealed majority of the farmers 'strongly agree' that precision farming practices are difficult to adopt (75.00%), followed by difficult to analyse soil samples or handle costly equipments (60.53%), difficult to understand (51.32%) and difficult to calculate grid wise nutrient requirement (48.68%). Whereas, 61.80 per cent of the farmers 'agree' that it is difficult to form the grids based on soil fertility and half of them agree to the statement that it is difficult to analyse moisture grid wise (50.00%).

Percentage of farmers who 'disagree' to the statements was difficult to apply nutrient grid wise (51.32%), difficult to manage pest and diseases grid wise (42.11%) and difficult to work out cost benefit ratio or cost of cultivation (40.79%), respectively.

Precision farming involves analysis of soil variability, formation of grids based on soil variability, calculation and application of chemical fertilizers and micronutrients grid wise and crop wise, analysis of soil moisture grid wise *etc.* Farmers expressed difficulties in doing these activities. These might be the reasons for majority of the farmers 'agree' with most of the complexity attributes of the precision farming practices.

On the other hand farmers might have felt adoption of precision farming practices such as grid wise application of nutrients, pest and disease control and calculation of cost benefit ratio were not much difficult. These might be the reasons for majority of the farmers disagree with difficult to apply nutrient grid wise, difficult to manage pest and diseases grid wise and difficult to workout cost benefit ratio or cost of cultivation. The findings were in conformity with the results of Mankar (1998).

5.2.4 Trialability

A careful observation of the data presented in Table 7 and Fig 14 revealed that majority of the farmers 'strongly agree' with precision farming practices can be tried on all types of soils (76.32%) and on a small scale in any given situation (56.58%). Whereas majority of the farmers 'agree' with precision farming can be tried in all seasons (63.16%), application of nutrient based on soil analysis can be tried in a small scale (63.16%), can be tried by any category of farmers (59.21%), plant protection measures can be tried in small scale (56.58%), precision farming can be tried in all climatic condition (55.26%), moisture analysis can be tried on small scale (53.95%) and formation of grids can be tried on small scale in precision farming (52.63%).

New ideas that can be tried on the installment plan are generally adopted more rapidly than innovations that are not divisible. Relatively earlier adopters of an innovation perceive trialability as more important than do later adopters (Gross, 1942, Ryan 1948). As precision farming practices such as soil variability analysis, soil moisture analysis, application of nutrients based on soil variability, control of pest and diseases *etc.* can be tried on small scale by all categories of farmers under all climatic conditions. After getting conviction on the technical feasibility and economic viability in small scale, farmers would go for large scale adoption of innovation. These might be the reasons for majority of the farmers agree with the trialability attributes of precision farming practices. The findings of the study are supported by the studies of Mankar (1998) and Rathakrishnan (2012).

5.2.5 Observability

Perusal of Table 7 and Fig 15 revealed about the perception of observability of precision farming by farmers. Majority of the farmers 'strongly agree' with saving or optimum utilization of chemical fertilizers (68.42%), grid wise increase in yield (64.47%) and grid wise quality of the produce (51.32%) were evident in precision farming. Whereas majority of the farmers 'agree' with variability in weeds population (69.74%), grid wise moisture status (67.11%), grid wise crop condition (67.11%), grid wise soil fertility status (65.79%), variability in pest and disease population (60.53%), uniformity of crop maturity (56.58%) and grid wise cost benefit ratio (55.26%) can be observed in precision farming.

Observability is the degree to which the results of an innovation are visible to others. Some ideas easily observed and communicated to other farmers, whereas other innovations are difficult to observe or to describe to others. The precision farming practices such as results of soil variability, results of soil moisture test, formation of grids based on soil variability, application of nutrients based on soil variability, control of pest and diseases based on intensity, grid wise crop yield, grid wise crop condition, grid wise yield quality, analysis of cost benefit ratio are easily observable and communicable to others. These might be the reasons for majority of the farmers agree with

observability attributes of precision farming practices. The findings were in conformity with the results of Mankar (1998) and Karthik and Manjunath (2011).

5.3 Relationship of independent variables with perception of precision farming by the farmers

5.3.1 Relationship of independent variables with perception of precision farming as whole by the farmer

Before going into details discussion of the results of correlation analysis a point to be mentioned here that, to the best of researcher's knowledge not many studies have been conducted in the past to attempt an in depth analysis on perception of precision farming in relation to their characteristics due to which it was not possible to discuss the results separately for each of the studied variables. Therefore, attempts are made to discuss the findings by considering a cluster of related variables in order to give proper meaning.

A perusal of Table 8 and Fig 16 clearly revealed that there was non-significant relationship between the personal characteristics of the farmers such as age, education level, family size, land holding and annual income and their perception of precision farming practices. From this it could be inferred that farmers belonging to different age groups, family size, education level, land holding and annual income perceived precision farming practice equally. In the light of these facts it is logical to observe that perception of precision farming was not affected by age, education level, family size, land holding and annual income. Another significant inference that could be apparently drawn on the basis of these findings is that scientist working on precision farming project have made sincere efforts in extending the benefits of precision farming to all farmers without giving much consideration for their age, education level, family size, land holding and annual income.

A cursory look at the contents of Table 8 and Fig 16 revealed that farmers characteristic related to communication namely extension contact and mass media participation were positively and significantly correlated with perception of precision farming. Thus, the perception about precision farming of those farmers having greater extension contact and mass media participation was significantly better than those farmers who score low on these variables.

The farmers with greater extension contact and mass media participation might have helped them in obtaining adequate information about precision farming practices due to which they might have formed a more favourable perception about precision farming. Increased extension contact with extension functionary responsible for implementation of precision farming project must have definitely helped the farmers in forming favourable perception of precision farming.

Innovative proneness is positively and significantly related to perception of precision farming. The important cause of innovative proneness is an underlying willingness to change and try new ideas. The farmers who are more prone to adopt innovations generally will have higher orientation towards risks, scientific technology and competition. These factors do naturally influence ones perception and hence these factors might have established a significant association with the perception of precision farming.

Crop productivity had positive and significant relationship with the perception of precision farming which means that those farmers who are more oriented towards higher crop productivity per acre were the ones who had perceived the precision farming as more favourable. As the land resources and size of the land holdings are shrinking day by day, the farmers becoming more and more oriented towards practices which maximize the crop productivity and profit per unit area with limited resources. Hence, they need more and more precise improved cultivation practices for higher productivity. The main aim of precision farming is to maximizing the productivity with optimum utilization of inputs. Therefore, the above findings seem logical and the farmers with higher productivity orientation might have agree with perception of precision farming practices.

Material possession had negatively significant relationship with the perception of precision farming which means that those farmers who posses more material were the ones who had perceived the precision farming as less favourable. Use of various agricultural equipment for selected agricultural operations of precision farming such as grid wise application of nutrient and plant protection measures might pose challenge resulting into negative relationship.

As already discussed elsewhere in this chapter, perception of precision farming by farmers had strong correlation with five out of the ten independent variables studied (Table-8). Further,

analysis was carried out to examine the contribution of the all ten variables in predicting the level of perception of precision farming by application of multiple regression analysis. The results of which are presented in Table 9. It could be clearly observed from the contents of Table -9 that only one out of ten variables studied namely crop productivity was found to be significant in explaining the variation in the level of perception of precision farming by the farmers. Hence, the variable crop productivity could be considered as good predictor of perception of precision farming by farmers. It could be implied from the significant regression coefficient values of crop productivity that the level of perception of precision farming by farmers increased by one unit when crop production of farmers increased by 1.125 units.

The values of coefficient of determination *i.e.* $R^2 = 0.616$ revealed that all the ten independent variables together explained 61.60 per cent of variation in the level of perception of precision farming by the farmers. The significant R^2 value revealed that these ten variables taken together explained a highly significant difference in the levels of perception of farmers. Only 61.60 per cent of variation in perception of farmers could be explained in the present study by these ten variables. It is implied that there are other unidentified variables not included in the present study whose contribution towards variation in perception of farmers is 38.40 per cent. Nevertheless, this study could identify variables responsible for appreciable extent of variation in the perception of precision farming by the farmers. The discussion held elsewhere in this chapter for significant relationships holds good here as well.

5.3.2 Relationship of independent variables with perception of relative advantages of precision farming by the farmers

It is interesting to note that similar trend of relationship of age, education level, family size, land holding and annual income with perception of precision farming was observed even when the data were analysed separately for the perceived attributes of precision farming practices.

A cursory look at the contents of Table 8 revealed that out of ten characteristics studied to assess the relationship with their perception of relative advantage of precision farming, four variables namely extension contact, mass media participation, innovative proneness and crop productivity exhibited positively significant relationship with the perception of relative advantages of precision farming, while the variable material possession exhibited negatively significant relationship with it. On the other hand, the variables like age, family size, education level, land holding and annual income did not show the significant relationship with perception of relative advantage of precision farming.

The communication characteristics of the farmers such as extension contact and mass media participation were positively significantly correlated with perception of relative advantages of precision farming practices. The farmers with greater extension contact and mass media participation might have helped them in obtaining adequate information about relative advantages of precision farming practices such as analysis of soil variability, application of nutrient based on soil variability and crop requirement, precise management of pest and diseases *etc.*

Innovative proneness is positively and significantly related to perception of relative advantages of precision farming practices. The farmers who are more prone to adopt innovations might have perceived favourably with relative advantages of precision farming practices.

Crop productivity had positive and significant relationship with the perception of relative advantages of precision farming practices. Past investigations of the perceived attributes of innovations almost universally report a positive relationship between relative advantage and rate of adoption. That is, the relative advantage of an innovation, as perceived by members of a social system, is positively related to its rate of adoption. The farmer who agree with the relative advantages of an innovations, adopt such recommendations at faster rate. Increase in yield or productivity per unit area depends directly on adoption of recommended practices. Therefore, people with higher crop productivity levels might be agree with the relative advantages of precision farming practices as the main aim of precision farming is to maximize the productivity with optimum utilization of resources.

Material possession had negatively significant relationship with the perception of relative advantages of precision farming practices which means that farmers who possess more materials were the ones who had perceived the relative advantages of precision farming practices as less favourable. The farmers who were using agriculture equipments such as plough, harrows, seed cum fertilizer drills, tractor etc might have felt the relative advantages of precision farming practices as less favourable.

As already discussed elsewhere in this chapter, perception of relative advantages of precision farming had strong correlation with five out of the ten independent variables studied (Table 8). Further, multiple regression analysis was carried out to determine the extent of contribution made by the independent variables and to identify those variables which contributed significantly towards the variation in perception of relative advantages of precision farming by the farmers. It could be clearly observed from the Table 10 that, out of ten variables studied, only one variable namely crop productivity was found to be significant in explaining variation in the level of perception of relative advantage of precision farming by farmers.

It could be also observed from the Table 10 that the F value ($F=8.910$) obtained was significant at one per cent level indicating that all the independent variables put together contributed significantly to the variation in the perception of relative advantages of precision farming by the farmers. The coefficient of determination (R^2) was 0.578 which revealed that 57.80 per cent of variation in the perception of relative advantages of precision farming by the farmers was explained by all the independent variables selected for the study.

It is implied that there are other unidentified variables not included in the present study whose contribution towards the variation in the perception of relative advantages of precision farming is almost equal to those studied. Nevertheless, this study could identify variables responsible for appreciable extent of variation in the perception of relative advantages of precision farming.

5.3.3 Relationship of independent variables with perception of compatibility of precision farming by the farmers

A cursory look at the contents of Table 8 revealed that out of ten characteristics studied to assess the relationship with their perception of compatibility of precision farming, four variables namely extension contact, mass media participation, innovative proneness and crop productivity exhibited positively significant relationship with the perception of compatibility of precision farming, while the variable material possession exhibited negatively significant relationship with perception of compatibility of precision farming. On the other hand, the variables like age, family size, education level, land holding and annual income did not show the significant relationship with perception of compatibility of precision farming.

As in case of perception of relative advantages of precision farming practices, extension contact and mass media participation exhibited positively and significant relationship with perception of compatibility of precision farming practices. The farmers with greater extension contact and mass media participation might have helped them in obtaining adequate information about various compatibility attributes of precision farming practices such as suitable for all types of soils, all size of landings, all seasons, different crops, *etc.*

Innovative proneness also exhibited positively and significant relationship with perception of compatibility attributes of precision farming practices. That means, farmers who are more prone to adoption innovations might have perceived favourably the compatibility aspects of precision farming practices.

It is again clear from the results that, crop productivity had positive and significant relationship with perception of compatibility attributes of precision farming practices. The compatibility of an innovation, as perceived by the members of a social system, is positively related to its rate of adoption. An idea that is more compatible is less uncertain to the potential adopters and fits more closely with the individual's situation. Such compatibility helps the individual give more meaning the new idea so that it is regarded as more familiar. The compatibility attributes of precision farming practices also might have fits more closely with the potential adopters and their situations. Productivity levels of potential adopters are usually high as they adopt more and more recommended practices. Therefore, the farmers with higher productivity might have agreed with the compatibility attributes of precision farming practices.

Material possession had also negatively significant relationship with the perception of compatibility attributes of precision farming practices which means that farmers who possess more and material were the ones who had perceived the compatibility aspects of precision farming practices as less favourable. The farmers who were using agricultural equipments such as seed cum fertilizers, tractors, power sprays etc might have felt less favourable with the compatibility aspects of precision farming practices.

It could be observed from the Table 11 that, the F value ($F=8.990$) obtained was significant at one per cent level indicating that all the independent variables put together contributed significantly to the variation in the perception of compatibility of precision farming by the farmers. The coefficient of determination (R^2) was 0.580 which revealed that 58.00 per cent of variation in the perception of compatibility of precision farming by the farmers was explained by all the independent variables selected for the study.

The results also revealed that, crop productivity again was found to be significant in explaining the variation in the level of perception of compatibility attributes of precision farming practices by the farmers.

It is implied that there are other unidentified variables not included in the present study whose contribution towards the variation in the perception of compatibility precision farming is almost equal to those studied. Nevertheless, this study could identify variables responsible for appraisable extent of variation in the perception of compatibility of precision farming. The discussion held elsewhere in the chapter for significant relationships holds good here as well.

5.3.4 Relationship of independent variables with perception of complexity of precision farming by the farmers

A cursory look at the contents of Table 8 revealed that out of ten characteristics studied to assess the relationship with their perception of complexity of precision farming, again four variables namely extension contact, mass media participation, innovative proneness and crop productivity exhibited positively significant relationship with the perception of complexity of precision farming, while the variable material possession exhibited negatively significant relationship with it. On the other hand, the variables like age, family size, education level, land holding and annual income did not show the significant relationship with perception of complexity of precision farming.

As in case of perception of relative advantages and compatibility of precision farming practices, extension contact and mass media participation again exhibited positive and significant relationship with complexity aspects of precision farming practices. Again the farmers with greater extension contact and mass media participation might have helped them in understanding various complexity aspects of precision farming practices such as analysis of soil variability, formation of grids based on soil variability, application of nutrients based on soil variability, *etc.*

Innovative proneness also again exhibited positive and significant relationship with perception of complexity attributes of precision farming practices. That means, the farmers who are more prone to adopt innovations might have agree with the complexity aspects of precision farming practices.

It is also again clear from the results that, crop productivity exhibited positive and significant relationship with perception of complexity attributes of precision farming practices. Complexity is the degree to which an innovation is perceived as relatively difficult to understand and use. Some innovations are clear in their meaning to the potential adopters while others are not. As it is clear from the results in Table 7, majority of the potential adopters are agree with the most of the complex aspects of precision farming practices. Therefore, the farmers with higher productivity (potential adopters) might be agree with the complex attributes of precision farming practices.

The material possession had negatively significant relationship with the perception of complexity attributes of precision farming practices, which means that farmers who posses more materials were the ones who had perceived the complexity attributes of precision farming practices as less favourable. The farmers who are using agricultural equipments such as seed cum fertilizer drill, tractor etc might have felt difficulty in adoption of precision farming practices

It could be observed from the Table 12 that the F value ($F=15.944$) obtained was significant at one per cent level indicating that all the independent variables put together contributed significantly to the variation in the perception of complexity of precision farming by the farmers. The coefficient of determination (R^2) was 0.710 which revealed that 71.00 per cent of variation in the perception of complexity of precision farming by the farmers was explained by all the independent variables selected for the study. The results also revealed that, crop productivity was again found to be significant in explaining the variation in the level of perception of complexity attributes of precision farming practices by farmers

It is implied that there are other unidentified variables not included in the present study whose contribution towards the variation in the perception of complexity of precision farming is almost one

third to those studied. Nevertheless, this study could identify variables responsible for appreciable extent of variation in the perception of complexity of precision farming.

5.3.5 Relationship of independent variables with perception of trialability of precision farming by the farmers

A cursory look at the contents of Table 8 revealed that out of ten characteristics studied to assess the relationship with their perception of trialability of precision farming, four variables namely extension contact, mass media participation, innovative proneness and crop productivity exhibited positively significant relationship with the perception of trialability of precision farming, while the variable material possession exhibited negatively significant relationship with perception of trialability of precision farming. On the other hand, the variables like age, family size, education level, land holding and annual income did not show the significant relationship with perception of trialability of precision farming.

As discussed earlier, the farmers with greater extension contact and mass media participation might have helped them in understanding the trialability attributes of precision farming practices such as precision farming can be tried on small scale, can be tried by any category of farmer, soil and moisture analysis can be tried on small scale, application of nutrients and pesticide can be tried on small scale *etc.*

Innovative proneness also exhibited positive and significant relationship with perception of trialability attributes of precision farming practices. That means, farmers who are more prone to adopt innovations might have perceived favourably the trialability attributes of precision farming practices.

It is also again clear from the results that crop productivity had positive and significant relationship with perception of trialability attributes of precision farming practices. Trialability is the degree to which an innovation may be experimented with on a limited scale. Trialability of an innovation, as perceived by members of a social system, is positively related to its rate of adoption. That means the potential adopters who agree with the trialability attributes of innovations, adopt such recommendations at faster rate. The crop productivity of potential adopters is high due to adoption of recommendations. Therefore, farmers with higher crop productivity levels might have perceived the trialability attributes of precision farming practices favourably.

Again the material possession negatively significant relationship with the perception of trialability attributes of precision farming practices, which means that farmers possess more of agricultural equipments and machinery were the ones who had perceived the trialability attributes of precision farming practices as less favourable.

It could be observed from the Table 13, the F value ($F=8.766$) obtained was significant at one per cent level indicating that all the independent variables put together contributed significantly to the variation in the perception of trialability of precision farming by the farmers. The coefficient of determination (R^2) was 0.574 which revealed that 57.40 per cent of variation in the perception of trialability of precision farming by the farmers was explained by all the independent variables selected for the study. The results also revealed that, crop productivity again was found to be significant in explaining the variation in the level of perception of trialability attributes of precision farming practices by the farmers.

It is implied that there are other unidentified variables not included in the present study whose contribution towards the variation in the perception of trialability of precision farming is almost equal to those studied. Nevertheless, this study could identify variables responsible for appreciable extent of variation in the perception of trialability of precision farming. The discussion held elsewhere in the chapter for significant relationships holds good here as well.

5.3.6 Relationship of independent variables with perception of observability of precision farming by the farmers

The results presented in Table 8 revealed that out of ten characteristics studied to assess the relationship with perception of observability of precision farming by farmers, four variables namely extension contact, mass media participation, innovative proneness and crop productivity exhibited positively significant relationship with the perception of observability of precision farming, whereas the variable material possession exhibited negatively significant relationship with perception of observability of precision farming. On the other hand, the variables like age, family size, education

level, land holding and annual income did not show the significant relationship with perception of observability of precision farming.

As discussed earlier, the farmers with greater extension contact and mass media participation might have helped them to expose various observability aspects of precision farming practices such as soil variability analysis, formation of grids based on soil variability, application of fertilizer based on soil variability and crop requirement, increase in yield *etc.* This might have helped the farmers to favourably perceive the observability attributes of precision farming practices.

Innovative proneness also exhibited positive and significant relationship with perception of observability attributes of precision farming practices. That means, the farmers who are more prone to adopt innovations, might have perceived favourably the observability attributes of precision farming.

The crop productivity again had positive and significant relationship with perception of observability attributes of precision farming. The observability of an innovation, as perceived by members of a social system, is positively related to its rate of adoption. That means, the potential adopters who agree with the observability attributes of innovations, adopt such recommendations at fast rate, that leads higher productivity. Therefore, farmers with higher crop productivity levels might have perceived favourably the observability attributes of precision farming practices.

It could be observed from the results in Table 14 that F value of 9.270 for the multiple regression was significant at one per cent level indicating thereby that all the independent variables put together made significant contribution in explaining the variation in level of perception. The value of coefficient of determination was 0.588 which revealed that as high as 58.80 per cent of the variation in the level of perception of observability of precision farming by farmers was contributed by the combined influence of all the independent variables considered in the study. However much of the variation in the level of perception of farmers was contributed by annual income and crop productivity. Therefore it could be implied that the degree to which observability of precision farming perceived by farmers is determined to a large extent by level of annual income and crop productivity. Hence, these two variables prove as good predictor of the level of perception of observation of precision farming.

5.4 Impact of precision farming practices on crop productivity and income of farmers`

5.4.1 Impact of precision farming on crop productivity

The result presenting in Table 15 gives better idea about difference in the crop productivity. More than one third (36.26%) crop productivity increase was noticed in cotton followed by 26.08 per cent in chilli, 17.08 per cent in sugarcane crop by virtue of implementation of precision farming. It was interesting to note that, increase in average yield of sugarcane, cotton and chilli before and after the adoption of precision farming practices were significant at one per cent level of probability as revealed by t-test.

The possible reasons attributed to this phenomenon is that all the farmers have adopted important precision farming practices like soil variability analysis, timely management of cultivation practices and right time application of nutrients as per advise of scientist during project implementation. These practices directly helped to increase in the productivity of the crops. During data collection process respondents affirmed that increase in productivity is mainly due to adoption of precision farming practices. The findings were in conformity with the results of Savita (2008)

5.4.2 Impact of precision farming practices on income of farmers

The result presented in Table 16 gives better idea about difference in the income of the farmers before and after implementation of the precision farming.

More than 70.00 per cent increase in the income level was noticed in cotton growers (75.63%) followed by 29.63 per cent increase for chilli growers and 24.51 per cent increase for sugarcane growers. Income of sugarcane, chilli and cotton growers hence increased significantly after the implementation of the precision farming project, as revealed by results of t-test (Table 16).

The farmers were guided to apply the fertilizers and micronutrients as per soil variability analysis and crop requirement. The farmers were even advised to take up need based plant protection measure and weed management practices. This might have reduced the cost of cultivation, increased productivity per unit area and increased the income of the farmers. The findings were in conformity with the results of Savita (2008).

5.5 Constraints faced by precision farming farmers in the adoption of precision farming practices

Constraints analysis is becoming an important thrust area of extension research now a days. The constraints analysis would help to lubricate the process of diffusion of recommended farm technologies among the farmers. Therefore, the possible constraints faced by the farmers in adoption of precision farming practices were given in Table 17.

It could be revealed from the Table 17 and Fig. 17 that overwhelming majority of the farmers (96.05%) indicated 'high initial cost' as major constraint. Adoption of precision farming practices. Formation of grids based on the soil variability, grid wise application of micronutrients, in some cases laying of drip lines, grid wise management of pest and diseases *etc.* These are very labour and cost intensive practices. These initial costs on precision farming practices might have lead to perceive this as a one of the important constraint. So, respondents perceived this as an important constraint.

Large majority of the farmers opined that (93.42%) 'difficulty in formation of grids based on soil variability' as another important constraints in adoption of precision farming . This practice involves meticulous collection and labelling of soil samples, reading of soil test reports and formation of grids based on soil variability. Lack of such competence among farmers lead to perceive this as a one of the important constraint.

'Difficulty in getting soil variability analysis' was also important constraint expressed by the majority of the farmers (92.11%). Lack of knowledge about soil sampling and lack of soil tasting/analysis facilities at local situation might have lead to this finding.

More than 80.00 per cent of the farmers expressed difficulty in identifying the pest and diseases grid wise(88.16 %), difficult to take up plant protection measures grid wise (86.84 %), difficulty in applying nutrients based on soil variability analysis (85.53%) and lack of knowledge about precision farming technologies (84.21%). Identification of pests and diseases and site specific nutrients application require more experience and involvement on the part of the farmers. Besides as reported large majority of farmers still feel they lack all the knowledge about precision farming technologies

Non availability of required inputs was also the important constraints expressed by majority (78.95%) of the farmers. So it is required to inform them the reliable source of availability of inputs along with the technologies

Lack of local technical expertise was another major constraint expressed by 59.21 per cent of farmers. Since precision farming is new concept, farmers need local technical guidance on regular basis that is why they might have expressed this problem.

Nearly one fifth of farmers experienced lack of finance and credit facilities (48.68%) as the constraints in adoption of precision farming practices. Precision farming practices such as drip irrigation, fertigation, application of nutrients grid wise etc are expensive which need credit linkages with financial institutions

Inadequate trainings and demonstrations as one of the constraint in adoption of precision farming as expressed by 46.05 per cent of the farmers. Precision farming practices are complex in nature due to which farmers might have expressed need for training and demonstration.

Other important constraints expressed by the considerable per cent of the farmers were lack of remunerative prices on quality of produce (43.42%), lack of skilled labour to operate and handle the equipment (40.78%), small size of land holdings (31.58%) and heterogeneity of cropping system (28.95%). Not fixing price as per the quality of the produce, non-availability of skilled labour, land fragmentation and diverse cropping system could be the reasons for above constraints.

SUMMARY AND POLICY IMPLICATIONS

India's population is projected to be around 1,350 million by 2020AD which requires food grain production of 343 million tonnes. Considering the current food grain production levels, India needs to raise food grain growth by not less than 4.00 per cent. On the other hand the available per capita cultivable land has declined from 0.48 ha to 0.14 ha. As the availability of land has decreased, application of fertilizers and pesticides become necessary to increase productivity and production. In this situation, it is essential to develop eco-friendly technologies for maintaining crop productivity. Improvements in productivity come from adoption of new technologies and increase in production efficiency. 'Precision farming' or 'Precision agriculture' aims at increasing productivity, decreasing production costs and minimizing the environmental impact on farming.

Precision farming is a form of agriculture where site specific management practices are adopted giving due considerations to the spatial variability of land in order to maximize crop production and minimize the environmental damage (Harshal *et al.*, 2006). Precision farming requires information about soil properties, landscape, elevation and how these characteristics affects the plant growth and crop progress throughout the field season. Precision farming technology would be a viable alternate to improve profitability and productivity. Precision agriculture gives farmers the ability to use crop inputs more effectively including fertilizer, pesticides and irrigation water.

Keeping the above facts in mind, the present study was designed to understand how farmers are perceived precision farming practices. The following specific objectives were formulated for the study.

1. To study the precision farming technique as perceived by farmers.
2. To analyze relationship between perception of precision farming technique and socio economic characters of farmers.
3. To study the impact of precision farming technique on productivity and income of farmers.
4. To identify the constraints faced in adoption of precision farming practices.

The study was an "Expost-facto" research carried out in Bagalkot, Belgaum, Dharwad, Haveri district of Karnataka. These districts are purposively selected for research study as Precision Farming Project under RKVY implemented by UAS Dharwad in these districts during the year 2011-2012. All the farmers covered under Precision Farming Project implemented by UAS Dharwad constituted in sample of the study. Thus the total sample size constituted for the study was 76 respondents.

In the light of the objectives set for the study, the dependent variables selected for the study were perception of precision farming. The variables age, family size, education, land holding, annual income, innovative proneness, crop productivity, extension contact, mass media participation and material possession were the independent variables.

A well structured interview schedule was used to collect the data from the farmers by personal interview method. The data collected were scored, tabulated and analyzed by using statistical tools such as frequency, percentage, mean, standard deviation, correlation and regression.

Major findings of the study

A. Profile of the farmers.

1. Majority (60.53%) of the farmers were middle aged category.
2. More than 60.00 per cent of the farmers studied upto high school and above.
3. More than fifty per cent (55.26%) of the farmers belonged to medium size family.
4. More than two fifth (40.79%) of the farmers belonged to medium and 30.26 per cent of farmers were big land holding category.
5. Nearly three fourth (72.37%) of the farmers belonged to high annual income category.
6. More than fifty per cent (53.95%) of the farmers belonged to medium mass media participation category.
7. More than two fifth (42.10%) of the farmers belonged to medium extension contact category and one third (34.21%) of the farmers were noticed in high extension contact categories.

8. With respect to innovative proneness, more than fifty (50.32%) of the farmers exhibited high innovative proneness.
9. More than fifty per cent of the farmers (55.26%) belonged to medium and 30.26 per cent farmers belonged to high level material possession category
10. The average productivity of major crops found to be in study area were, 42.30 tonne/ac in sugarcane, 25.10 q/a in maize, 24.24 q/ac in turmeric, 6.78 q/ac in wheat, 8.13q/ac in cotton, 7.68 q/ac in soyabean, 4.04 q/ac in chilli and 6.60 q/ac in groundnut.

B. Perception of precision farming practices by the farmers

1. With respect to perception of relative advantage, majority of farmers strongly agree with precision farming helps to apply nutrients based on soil variability (80.26%) and adoption of precision farming practices increases the yield (68.42%).
2. With regard to perception of compatibility attributes, majority of the farmers strongly agree with precision farming practices suits for all types of soils (77.63%) and for all types of crops (73.68%).
3. Regarding perception of complexity attributes,, majority of the farmers strongly agree with precision farming practices are difficult to adopt (75.00%) and difficult to analyse soil samples (60.53%).
4. Pertaining to perception of trialability attributes,, majority of the farmers strongly agree with precision farming practices can be tried on all types of soils (76.32%) and on a small scale in any given situation (56.58%).
5. With respect to perception of observability attributes, majority of the farmers strongly agree with precision farming help in saving or optimum utilization of chemical fertilizers (68.42%) and grid wise increase in yield (64.47%) can be observed.

C. Relationship between socio-economic characteristics and perception of precision farming by the farmers

1. Perception of precision farming by the farmers was positively and significantly correlated with the variables viz., extension contact, innovative proneness, crop productivity and mass media participation. On the other hand material possession had negatively significant relationship with perception of precision farming.
2. Perception of attributes of precision farming by the farmers were positively and significantly correlated with the variables viz., extension contact, mass media participation, innovative proneness and crop productivity exhibited. On the other hand material possession exhibited negatively significant relationship with all the attributes of precision farming.
3. All the ten independent variables taken together explained 61.66 per cent of variation in the level of perception of precision farming by the farmers. Only one variable namely crop productivity contributed significantly towards variation in the perception of precision farming by the farmers.
4. Among the ten independent variables selected, only crop productivity was significant in predicting the variation in the perception of relative advantage of precision farming. All the variables taken together contributed to 57.80 per cent variation in the perception of relative advantage of precision farming by the farmers.
5. More than 58.00 per cent of variation in perception of compatibility of precision farming was explained by the independent variables. Of the ten variables selected, only crop productivity was observed to be contributing significantly in total variation in the level of perception of compatibility of precision farming by the farmers.
6. Crop productivity was the major contributing variable in explaining total variation in the perception of complexity of precision farming. All the variables together contributed to 71.00 per cent variation in the precision farming by the farmers.
7. Crop productivity was found to be significant in explaining the variation in the perception of trialability of precision farming. All the variables together contributed to 57.40 per cent variation in the perception of precision farming by the farmers.

8. About 58.80 per cent of variation in the perception of observability of precision farming was explained by all the ten variables selected for the study. Only crop productivity was found to be significant in exploiting the variation in the perception of trialability of precision farming by the farmers.

D. Impact of precision farming practices on crop productivity and income of the farmers

1. The percentage increase in average yield of sugarcane, cotton and chilli after adopting precision farming were 17.80, 36.26 and 26.08, respectively. The per cent increase in yield before and after the adoption of precision farming was significant as revealed by 't' test.
2. The per cent increase in income of sugarcane, cotton and chilli after adoption of precision farming practices were 24.51, 75.63 and 29.63, respectively. The per cent increase in average per acre income after adoption of precision farming practices was significant as revealed 't' test.

E. Constraints faced by the precision farming farmers in the adoption of precision farming practices

1. The major constraint faced by the farmers in precision farming was high initial cost (96.05%). Difficulty in formation of grids based on soil variability (93.42%), difficulty in the soil variability analysis (92.11%), difficulty in identifying the pest and diseases grid wise (88.16%), difficulty to take plant protection measures grid wise (86.64%), difficulty to apply nutrients based on soil variability analysis (85.53%), lack of knowledge about precision farming technologies (84.21%) and non availability of required inputs (78.95%) were other major constraints faced by the farmers.

Implications of the study

In the light of the findings of the study and from the observations of the researcher during data collection, following implications are made for the effective improvement in precision farming.

- The study reported aptly that majority of the respondents agreed with perceived attributes viz., relative advantage, compatibility, complexity, trialability and observability of precision farming practices. This goes with an early sociological dictum "if men perceives situation as real, they are real in there consequences" (Tomees and Znaniek, 1927). Even after accepting all the perceived attributes of this technology one could find lesser diffusion of the same in different places/ regions. To tap all advantages of this technology it is very much necessary to reach large number of farmers by concerted efforts of all the line departments as well as technical and financial institutions. Increase in productivity of different crops is much talked about in today's food scenario to match growing population requirement. Precision farming technology becomes best alternative to address this issue as majority farmers expressed affirmatively the same. Looking into advantages, it is strongly advocated to replicate the 'Israile' model of precision farming by state and central governments.
- The perception of precision farming by farmers has been significantly influenced by variables such as extension contact, mass media participation, innovative proneness and crop productivity. In this regard, the findings call for concerted efforts from all the developmental departments, to advantageously manipulate these variables in order to mould the perception of precision farming practices by farmers.
- Average yield level and income of farmers increased significantly after intervention of precision farming practice. This tangible benefit could be exploited by the extension agencies to motivate other farmers for adoption of these practices. Before advocating this, the study on cost benefit analysis of precision farming in different farmers field practicing different cropping system could be taken up. The results of this study thus become helpful for the extension agencies to diffuse technology with more ease.
- 'High initial cost' was important constraint expressed by all most all the respondents. Formation of grids based on the soil variability, grid wise application of micronutrients, in some cases laying of drip lines, grid wise management of pest and diseases *etc.* are very labour and cost intensive practices. So, it is strongly suggested to develop cost and labour effective grid formation and nutrient application methods which could fit well into Indian

farmers conditions and resource matrix. There are such technologies developed using sensors, available in developed countries. The possibility of exploiting such options available elsewhere to fit into prevailing conditions of the country should be worked out. Cost of micronutrients is higher than the cost of other fertilizers to which farmers accustomed. So, looking into the benefits of micronutrients use government should think of providing more economical micronutrients to the farmers.

- 'Formation of grids based on soil variability' was another major constraint expressed by almost all farmers. This practice demands meticulous collection and labelling of soil samples, reading report and marking in the field to separate/divide the fields into grids. Lack of such competence among farmers lead to perceive this as a one of the important constraint. So it is recommended to identify this as one of the training needs to the development of training curriculum to address this issue and subsequently conduct the training programmes that would enable the farmers to carryout this activity with ease.
- 'Difficulty in getting soil variability analysis' was also important constraint identified by the study. Majority of the farmers expressed their ignorance about method of collecting soil sample, centers of soil analysis and understanding the given report as mentioned earlier. Training farmers in these skills should be planned and executed by various training institutes working under university, line departments and other developmental organisations. This constraint should also be addressed by arranging the soil variability analysis directly by extension agencies of line departments and educating farmers about its usefulness.

Suggestions for future research

1. The present study focused only on the beneficiaries of precision farming project. Similar studies can also be attempted for comparative precision farming and conventional method of farming.
2. A study on training needs of precision farming can also be taken up.
3. A study can be conducted to know the knowledge and adoption of precision farming practices.
4. The independent variables included in the present study have explained 61.60 per cent of variation in the level of perception of precision farming by the farmers. Therefore, studies with some other independent variables are needed so as to arrive at concrete conclusions.
5. In-depth analysis of the constraints expressed by the precision farming farmers can be taken up in order to find out practical solutions for each problem.

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Appendix I: Interview schedule

STUDY ON PERCEPTION OF PRECISION FARMING BY THE FARMERS

Respondent No.:

Part-I: General Information

1. Name of the Farmer : _____ Phone No.: _____
2. Name of the Village : _____
3. Name of the Taluk : _____
4. Name of the District : _____

Part-II: Socio-economic Characteristics of Farmers

1. **Age** (in completed years) : _____
2. **Family Size**: Male : _____ Female : _____ Total : _____
3. **Educational Level** : _____
4. **Land Holding (in Ac)** : (a) Rainfed _____ (b) Irrigated _____ (c)
Horticulture _____ (d) Total _____
5. **Annual Income in (Rs.)** :
- a) Agriculture : _____ b) Subsidiary Occupation : _____
- c) Other Sources : _____ d) Total : _____

7. **Extension contact**: Do you meet Extension Worker? Yes/No

If yes, indicate how often do you contact with the following Extension Workers / Officials.

Sl. No	Extension workers	Extent of contact				
		Once in a week	Once in a fort night	Once in a month	Occasionally	Never
1	Agriculture Assistant					
2	Assistant Agriculture Officer					
3	Agriculture Officer					
4	Assistant Director of Agriculture					
5	Agriculture Scientists					
6	Input Dealers					
7	Extension Personnel of Private Companies					

8. Mass Media Participation :Please Indicate whether you are possessing the following Mass Media and frequency of use by clicking right mark(✓)

Sl. No.	Mass Media	Subscribed/ Possessed	Programmes	Frequency of use		
				Regular	Occasional	Never
1	News Paper		Agril. Articles			
			News			
			Entertainment			
2	Farm Magazines		Agril. Articles			
			News			
			Entertainment			
3	Radio		Agril. Programmes			
			News			
			Entertainment			
4	TV		Agril. Programmes			
			News			
			Entertainment			

9. Innovative Proneness Please indicate your degree of agreement or disagreement to the following statements by clicking right mark (✓)

SI.No	Statements	SA	A	UD	DA	SDA
1	I am very much interested in adopting whatever new crops and cultivation practices are there.					
2	Since I am not sure of success of new cultivation practices of crops, I would like to wait others to adopt.					
3	Since new practice of crop cultivation is not profitable, I am not interested in it.					
4	I try to keep myself well informed about any new crop cultivation practices and try to adopt as soon as possible					
5	New crop cultivation practices are not easily adoptable and hence I do not adopt.					

SA-strongly agree, A-agree, UD-undecided, A-disagree and SDA-strongly disagree.

9. Crop Productivity: Please indicate the crops grown in last year.

Sl. No	Season	Crops	Area (Ac)	Yield(t/ ac)	Marketed Price
A.	Agriculture				
1	Kharif	1.			
		2.			
		3.			
2	Rabi	1.			
		2.			
		3.			
3	Summer	1.			
		2.			
		3.			
B.	Horticulture	1.			
		2.			
		3.			

10. Material Possession : Please indicate the materials possessed / owned

Sl. No.	Particulars	Number
1.	Wooden plough	
2.	Mould board plough	
3.	Iron plough	
4.	Seed drill	
5.	Harrow	
6.	Seed-cum-fertilizer drill	
7.	Cultivators	
8.	Power tiller	
9.	Knapsack Sprayer	
10.	Power Sprayer	
11.	Tractor	
12.	Motor Cycle	
13.	Radio	
14.	Television	
15.	Mobile phone	
16.	Thresher	
17.	Pumpsets	
18.	Bullock cart	

PART III: PERCEPTION OF PRECISION FARMING PRACTICES

Below given are the statements regarding perception of precision farming practices by farmers you are requested to go through critically and tick mark (☐) in appropriate columns against each statement to show your degree of perception of five point continuum.

Sl. No	Statements	SA	A	UD	DA	SDA
I Relative advantage						
1	Precision farming helps to apply nutrients based on soil variability					
2	Application of nutrients based on soil variability results in balanced application of nutrients.					
3	It helps in application of nutrients based on crop requirements.					
4	Application of nutrients based on soil variability results increase nutrient use efficiency and there by increases net profit.					
5	It aims at precise management of weeds.					
6	It aims at precise management of pests.					
7	It aims at precise management of diseases.					
8	Timely management of cultivation practices increase quality of the produce.					
9	It helps to know the right time of application of inputs.					
10	Adoption of precision farming practices increases the yield.					
II Compatibility						
1	It suits for all the types of soils					
2	It suits for all the types of land holdings					
3	It suits for all the types of crops					
4	It is suitable for all seasons					
5	It is suitable for all agro climatic condition					
6	It suits to all improved cultivation practices					
7	It is economically compatible to all types of farmers					
8	It is suitable for people of all education categories					

SA-strongly agree, A-agree, UD-undecided, A-disagree and SDA-strongly disagree.

Sl.No	Statements	SA	A	UD	DA	SDA
III Complexity						
1	Precision farming practices are difficult to understand					
2	Difficult to analyse soil samples or handle costly equipments					
3	Difficult to form the grids based on soil fertility analysis					
4	Difficult to calculate grid wise nutrient requirement					
5	Difficult to apply nutrient grid wise					
6	Difficult to analyse moisture grid wise					
7	Difficult to manage pest and diseases grid wise					
8	Difficult to workout cost benefit ratio or cost of cultivation					
9	Difficult in getting necessary inputs and other resources for practicing precision farming at small sized grids					
10	Precision farming practices are difficult to adopt					
IV Trialability						
1	Precision farming practices can be tried on a small scale in any given situation					
2	Precision farming practices can be tried by any category of farmers					
3	Application of nutrient based on soil analysis can be tried in a small scale					
4	Moisture analysis can be tried on small scale					
5	It can be tried on all type of soils					
6	It can be tried in all climatic conditions					
7	It can be tried in all seasons					
8	Plant protection measures can be tried in small scale					
9	Formation of grids can be tried on small scale					

SA-strongly agree, A-agree, UD-undecided, A-disagree and SDA-strongly disagree.

Sl. No	Statements	SA	A	UD	DA	SDA
V. Observability						
1	Grid wise soil fertility status can be observed					
2	Grid wise moisture status can be observed					
3	Variability in weeds population can be observed					
4	Variability in pest and disease population can be observed					
5	Savings or optimum utilization of chemical fertilizers can be observed					
6	Grid wise crop condition can be observed					
7	Grid wise quality of the produce can be observed					
8	Uniformity of crop maturity can be observed					
9	Grid wise increase in yield can be observed					
10	Grid wise cost benefit ratio can be observed					

SA-strongly agree, A-agree, UD-undecided, A-disagree and SDA-strongly disagree.

PART IV: Impact of Precision Farming Technique on Income and Productivity

Income of Farmers: Please indicate crop grown under precision farming and yield obtained.

Crop	Area	Yield(q/ac)	Marketed price	Gross return obtained	Approximate cost of cultivation	Net return

Productivity of Crop

Crop	Area (in ac)	Before precision farming		After precision farming	
		Production (q/ac)	Productivity (kg/ac)	Production (q/ac)	Productivity (kg/ ac)

PART-V: Constraints faced in adoption precision of farming practices

Sl. No	Constraints	Remarks	
		Yes	No
1.	High initial cost		
2.	Difficulty in the soil variability analysis		
3.	Difficulty to take plant protection measures grid wise.		
4.	Difficulty in formation of grids based on soil variability.		
5.	Lack of local technical expertise		
6.	Difficulty to apply nutrients based on soil variability analysis.		
7.	Difficulty in identifying the pest and diseases grid wise.		
8.	Non -availability of required inputs.		
9.	Lack of knowledge about precision farming technologies		
10.	Lack of finance and credit facility		
11.	Inadequate training and demonstrations		
12.	Small size of landholdings for adoption of precision farming.		
13.	Lack of skilled labour to operate and handle the equipments		
14.	Lack of remunerative prices based on quality of produce		
15.	Heterogeneity of cropping system.		

A STUDY ON PERCEPTION OF PRECISION FARMING BY THE FARMERS

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2014

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ABSTRACT

A study was purposively conducted in Bagalkot, Belgaum, Dharwad and Haveri districts of North Karnataka state during 2013-14 with a sample of 76 farmers. The data was collected by personal interview method using structured schedule to assess the socio-economic profile, perception level, impact assessment and constraints of precision farming farmers.

The results pertaining to perception of various attributes of precision farming practices revealed that majority of the farmers strongly agree with precision farming helps to apply nutrients based on soil variability (80.26%), precision farming practices suits for all types of soils (77.63%), precision farming practices are difficult to adopt (75.00%), precision farming practices can be tried on all types of soils (76.32%) and savings or optimum utilization of chemical fertilizers can be observed (68.42%). Perception of precision farming by the farmers was positively and significantly correlated with the variables *viz.*, extension contact, innovative proneness, crop productivity and mass media participation. While material possession had negatively significant relationship with perception of precision farming. Regression analysis revealed that, all the ten independent variables taken together explained 61.60 per cent of variation in the level of perception of precision farming by the farmers. Only one variable namely crop productivity contributed significantly towards variation in the perception of precision farming by the farmers.

The percent increase in average yield of sugarcane, cotton and chilli after adopting precision farming practices were 17.80, 36.26 and 26.08, respectively. The percent increase in income of sugarcane, cotton and chilli after adoption of precision farming practices were 24.51, 75.63 and 29.63, respectively. The major constraint faced by the farmers in precision farming were high initial cost (96.05%), difficulty in formation of grids based on soil variability (93.42%) and difficulty in the soil variability analysis (92.11%).