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RESEARCH ARTICLE :

An economic perspective of precision farming technology adoption in paddy- a study from north eastern Karnataka

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SUMMARY : The ecosystem for technology and digital solutions is expanding at an impressive pace.Though India produces a large quantity of food grain, Indian farmers are not major noticeable at the global economic competition arena. The high cost of production and low productivity, lack of timely start of research on advanced science and poor grasp over cutting-edge technologies are some of the main problems of developing countries like India. The principle technology in Indian agriculture should be efficient, practical, cost effective and free from pollution. Precision farming can address both economic and environmental issues that surround production agriculture today.The increasing need to produce more from less available resources and demand for quality produce are the pressing needs for adopting precise way of farming to optimize the limited resources. Though PF is widely adopted in developed countries, the adoption of it in India is yet to take a firm ground primarily.High-tech nature of traditional PF technologies developed in advanced countries created a real challenge to search for suitable PF technologies for developing countries. Such an attempt has been made through present paper by analyzing the factors affecting adoption and constraints faced by adopters. Persuasion by the project staff and supply of technical know-how by the University scientists has influenced the farmers to adopt PF. It was noted that labour requirement, price constraints and managing crop as per grids were major constraints faced by them. Considering the adoption strategy of precision farming and its benefits, the extension workers have scope to bring awareness among farming community by various means.

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BACKGROUND AND OBJECTIVES

The implications of dramatic shifts for economic development, urbanization and energy consumption are immense and needs a viable and sustainable technology not only for the lifestyle but also to meet the huge food grain requirement of 480 million tonnes (Mt) by the year 2050 Bisoyi (2006), with the increasing challenge of biotic and abiotic stresses experienced by crops,. Thus, introduction and adoption of modern technology in the primary and major sector that is in Indian agriculture is inevitable. It is

true for other developing countries also. Agriculture, like other industries, has made entry into the knowledge-based era, leaving its previous resource-based nature. Indian agriculture has passed the transitional transformation from subsistence to conservational and from conservational to commercialization. Future agriculture will be severely competitive, knowledge intensive and market driven. WTO agreement and liberalization of agricultural trade have created not only new scopes but also new threats to the agriculture of developing countries. Removal of quantitative restrictions on import from 1 April, 2001 in India made quality and cost competitiveness the two most important factors to sustain in the globalized market.

Though India produces a large quantity of food grain, Indian farmers are not major noticeable at the global economic competition arena. The high cost of production and low productivity, lack of timely start of research on advanced science and poor grasp over cutting-edge technologies are some of the main problems of developing countries like India. Increasing the productivity on small-scale farms in developing countries is a critical part of a solution to the food insecurity problem. To face all these new challenges, increasing the productivity level of a pollution-free product is inevitable. This can be realized by applying advanced, environmental friendly technology, which can manage and allocate all resources efficiently for sustainable development of agriculture. Precision farming (PF) is such a new emerging, highly promising technology, that helps in dealing with these challenges by proper and effective management of soil and crop variability with the use of information technology. In the present situation, the potential of precision agriculture in India is limited by the lack of appropriate measurement and analytical techniques for agronomically important factors. The increasing need to produce more from less available resources, the decline in agricultural growth rate, high cost of inputs, scarcity of farm labours, indiscriminate use of fertilizer and pesticides, as well as demand for quality produce are the pressing needs for adopting precise way of farming to optimize the limited resources.

PF is conceptualized by a system approach to re-organize the total system of agriculture towards a low-input, high-efficiency, and sustainable agriculture. High-tech nature of traditional PF technologies developed in advanced countries created a real challenge to search for suitable PF technologies for developing countries. But over time, rapid changes in the socio-economic pattern of some developing countries, such as India, China, and Brazil, created new scope and opportunities for PF to be applied in these countries.It is considered as the agricultural system of the 21st century, as it symbolizes a better balance between reliance on traditional knowledge, information and management-intensive technologies. Though it is widely adopted in developed countries, the adoption of precision farming in India is yet to take a firm ground primarily. The initiative of precision farming in India through various projects under both agriculture and horticulture has been done in various institutes and organizations like Space Applications Centres like ISRO, Ahmedabad, M. S. Swaminathan Research Foundation, Chennai, ICAR Institutes such as IARI, New Delhi drawn up plans to do precision agriculture experiments in the institute's farm especially through State Agricultural Universities (SAUs), Project Directorate of Cropping Systems Research at Modipuramand Meerut in UP, etc. It is important to note that the initiation of PF has to be done through the demonstrations by research institutions, dissemination about PF by extension agencuies and through SAUs etc.

The technology has been currently implemented in Karnataka state under the RKVY funded project on precision farming in selected field crops since 2011-12. The project was implemented through the three SAUs in the Karnataka state with UAS, Raichur as the leading centre to guide the other two Agricultural Universities (UAS, Dharwad and UAS, Bangalore) in the project activities. Farmers' participatory approach was adopted to execute the project at the farmers' fields of Raichur, Kalaburgi and Koppal districts, covering an area of 100 acres each in cotton, pigeonpea and paddy crops, respectively, that represent major field crops of the North-Eastern Karnataka zone, along with on-farm research demonstration plots (5.00 acres in each crop) at four research stations of UAS, Raichur (Patil *et al.*, 2013). The present paper brief about the perspective of PF adoption, factors responsible for adoption and constraints faced by farmers growing paddy.

RESOURCES AND METHODS

The study was conducted in Karnataka state with a focus on the North Eastern Karnataka region in the jurisdiction of UAS, Raichur. However, the study area

confined to village Jangamarakalgudi of Gangavathi taluk, Koppal district of North Eastern Karnataka as RKVY-Precision Farming project under paady was implemented in this district. The precision farming adopted farmers refers to those who are the beneficiaries of precision farming project of UAS, Raichur. The number of farmers who adopted precision farming for paddy were 38. Primary data were collected from the farmers who adopted precision farming techniques in paddy since last three years. The interview schedule was pre-tested which led to the adequate modification of the instrument. The data were collected from the sample farmers by personal interview method using the pretested schedule during the period of January and February for the agricultural year 2014-15.

Implementation of PF has vast and wide range of using tools or technologies. But in the present study, technologies used were grid soil sampling, GPS, GIS, variable rate applicators/ techniques and crop sensors.The objective of present paper was to analyze the factors responsible for adoption of PF which were stated as reasons for adoption of PF and constraints faced by the paddy growers who have adopted PF in their fields. The suitable tool for this was found to be Garrett's ranking technique. As per this method, respondents were asked for various reasons for which they have adopted precision farming and constraints that they were faced in practicing precision farming. Depending upon the level of reasons influencing adoption of precision farming and extent of constraints faced by them, rankings were assigned separately to each component of reasons and constraints influencing different respondents. The results of such rankings were converted into score value by using following formula :

$$\text{Percent position} = \frac{100 \times (R_{ij} - 0.5)}{N_j}$$

where,

R_{ij} = Rank given for the i^{th} factor by j^{th} respondent.

N_j = Number of factors ranked by the j^{th} respondent.

The per cent position of each rank was converted to scores by referring to tables given by Garret and Woodworth (1969). Then for each factor, the scores of individual respondents were summed up and divided by the total number of respondents for whom scores were gathered. The mean scores for all the factors were ranked and presented in results.

OBSERVATIONS AND ANALYSIS

Opinion survey was conducted to elicit the reasons for participation in precision farming in paddy by the farmers. The results of Garette ranking were presented in Table 1. Persuasion by the project staff was ranked as first reason for participation in precision farming by the farmers. This indicated that farmers have got interest due to effective training programme conducted by the University staff. Supply of technical inputs by the University scientists, free supply of inputs by the University, possibility of getting higher yield were the important reasons quoted by the farmers to participate in precision farming. The last rankings were observed as motivated by neighbour farmers and possibility of getting higher profit.This indicated that farmers who adopted PF do not follow the practices blindly as practiced by other farmers. Similar to the present study, the study conducted by **Pandit** *et al*. (2012) has elicited in their study that formal education, farm size, and number of precision farming meeting attended by farmers had positive effect on adoption of precision farming technologies.

Table 1: Reasons for participation in precision farming

Sr. No.	Reasons	Paddy	
		Score	Rank
1.	Persuasion by the project staff	71.64	I
2.	Motivated by neighbour farmers	34.61	VIII
3.	Supply of technical know-how by the University scientists	58.17	II
4.	Free supply of inputs by the University	48.89	IV
5.	Possibility of getting higher yield	50.20	III
6.	Better utilization of land capability	47.41	V
7.	Possibility of saving in inputs	42.41	VI
8.	Overall helps in saving cost of cultivation	41.69	VII
9.	Possibility of getting higher profit	23.17	IX

The focus of the study was to analyze the factors that influence the adoption of precision farming in the study area. The empirical evidences attained from the statistical analysis were indicated the percentage score and the scale value were obtained by employing Scale Conversion Table given by Garrett ranking table. The scale value of first rank to ninth rank which were calculated based on percentage score (Table 1) were shown in detail in Figure 1. Similar results were reported in study conducted by Ravikumar (2016).

The constraints in adoption of precision farming at farm level were sub divided into production constraints, marketing and management constraints. The results were presented in Table 2. Requirement of more labour to identify the variability and management of variability of soil was identified as major production constraint faced by the farmers, followed by inadequate size of landholdings for adoption of precision farming technology and laser leveling problem. In addition, farmers also faced constraint with respect to lack of technical skill to follow precision farming recommendations like grid making, GPS and GIS handling. Similar studies were conducted by Robertson *et al.* (2012) and Gabriel (2014).

Less remunerative price for produce followed by price fluctuation were stated as the top most marketing constraints. The other marketing constraints faced by farmers were high transportation cost, lack of marketing information and no premium price for precision output. With respect to management constraints, farmers stated major constraints as difficult to go for grid sampling at the beginning of every season followed by precision farming requires more time for implementationand soil analysis at the beginning of every season.

Conclusion :

The agriculture sector has attracted large conglomerates, leading IT companies, investors, and young innovators in India; the ecosystem for technology and digital solutions is expanding at an impressive pace. The principle technology in Indian agriculture should be efficient, practical, cost effective and free from pollution. The sustainability factor should be looked at the ability of agricultural land to maintain acceptable levels of production over a long period of time, without degrading the environment. Digital technology in Indian agriculture is not about big box solutions only. A large number of young entrepreneurs have ventured into this sector to tackle specific challenges. The technology thrust of these ventures has been on reducing the time duration of crop cycles, saving on water and energy, reducing the usage of agro-chemicals, automating for efficient farm management and strengthening farmer market linkages.

Basic drawback of technology adoption in agricultural farming in India is that many of these

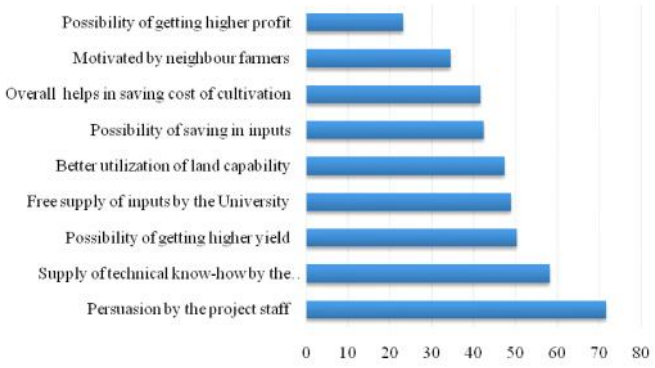

Fig. 1 : Reasons for participation in precision farming

Table 2 : Constraints in adoption of precision farming at farm level

Sr. No.	Constraints	Paddy	
		Score	Rank
Production constraints			
1.	Precision farming require more labour to identify the variability and management of variability of soil	65.39	I
2.	Inadequate size of landholdings for adoption of precision farming technology	40.71	III
3.	Lack of technical skill to follow precision farming recommendations	37.15	IV
4.	Land leveling problem	57.50	II
Marketing constraints			
1.	Less remunerative Price for produce	75.00	I
2.	High transportation cost	24.00	V
3.	Price fluctuation	60.00	II
4.	Lack of marketing information	40.15	IV
5.	No premium price for precision output	48.84	III
Management constraints			
1.	Precision farming requires more time for implementation	58.60	II
2.	Inadequate training and demonstration about precision farming	27.00	IV
3.	Difficult to go for grid sampling at the beginning of every season	60.18	I
4.	Soil analysis is difficult	54.21	III

technologies used including precision farming are at an infant stage, and pricing of equipment and services is hard to pin down. Even though some farmers had started to use precision farming methods, majority of the farmers are still not aware about precision farming. This can make our current economic statements about a particular technology dated. Precision farming can address both economic and environmental issues that surround production agriculture today. Questions remain about cost-effectiveness and the most effective ways to use the technological tools, but the concept of "doing the right thing in the right place at the right time" has a strong intuitive appeal. It was found from the study that the farmers who were not adopted precision farming were in the following misconceptions about the adoption of precision farming.

– There is misconceptions among the farming community that precision farming is only possible with high cost invested equipments, it involves more cost than conventional farming.
– Farmers are in misbelief that it can be only adopted by large farmers and small farmers cannot adopt it.

These are false with respect to reality. Precision farming does not has any compulsion of using high invested equipment or sophisticated tools. A knowledge among farmers to use inputs at variable rate, soil sampling and analysis also signifies precision farming and these knowledge base can be very well applied at small farms also. Hence the extension workers has scope to remove the misconception among farmers about the cost of precision farming implementation. Though the equipments used in precision farming are not affordable for the individual farmer in Indian farming condition, those are affordable on co-operative or on collective basis by farmers.Through the development of technology over time, by the good knowledge base the constraints faced in precision farming are expected to reduce. Considering the adoption strategy of precision farming and its benefits, there is a need to bring awareness among farming community through demonstration by extension agencies.

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