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An empirical analysis on resource use efficiency and constraints in adoption of precision farming in banana in Theni district, Tamil Nadu

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ABSTRACT

Banana is the second most important fruit crop in India, and India ranks first in banana production in the world. Tamil Nadu leads in both area and production of banana in India. Precision farming technique is getting wide acceptance in banana cultivation owing to its higher yield and profitability. This paper attempts to study resource use efficiency of different farm inputs used in precision farming and conventional farming as well as constraints in adoption of precision farming in banana. It was found in the result that regression coefficients for human labour, tissue culture (TC) plants/suckers, manures and fertilizers, and plant protection chemicals in precision farming as well as in conventional farming were positive and significant. Thus, On the basis of above, it is concluded that input use could be increased in order to get maximum return in both the cases. Percentage increase in return was found to be comparatively higher in precision farming for percentage increase in human labour and plant protection chemicals. The results also revealed that the problems in power supply, lack of marketing facilities were major infrastructural constraints. The high cost of drip and fertigation system, high input cost and price instability were the major economic constraints. The lack of technical expertise and resource persons were the extension constraints in adoption of precision farming. Improper price policies and lack of support from agriculture department were the major administrative constraints. Policy measures are required to overcome these constraints.

Keywords: Precision farming, resource use efficiency, banana, garrett ranking

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Banana is one of the oldest fruits known to mankind. It is the second most important fruit crop in India next to mango. India is the largest producer of banana in the world. Banana is an important fruit crop of many tropical and subtropical regions of India. India shares around 27.8 per cent in world banana production followed by China around 9.9 per cent. Banana is

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cultivated in India in an area of 802.6 thousand ha. Total banana production in India is 29724.6 thousand MT and productivity is 37.0 MT/ha. Tamil Nadu is the leading state in India with respect to area and production of banana when comparing to all other states. Tamil Nadu shares around 19.0 per cent in India's total banana production followed by Maharashtra around 16.3 per cent. Banana is cultivated in an area of 118.04 thousand ha in Tamil Nadu. Its production is 5650.0 thousand MT and productivity is 47.9 MT/ha (Indian Horticulture Database, 2015).

Precision farming is an advanced farming technique which ensures maximum output with minimum resource use. Banana is being cultivated under precision farming in many parts of the country and farmers are reaping its benefits. Precision farming may be defined as an accurate application of agricultural inputs for crop growth considering relevant factors such as soil, weather and crop management practices. It is information and technology based farming system where inputs are managed and distributed on a site-specific basis for long term benefit. Precision farming is quite new and mostly technology-driven approach. It is a managerial approach to the cultivation of crops by considering spatial and temporal variation in soils, rainfall and adopting management techniques to reduce cost, efficient use of inputs and reduce environmental pollution. It is a farm management concept based on modern information technologies such as GPS (Global Positioning System), Remote Sensing Technology and GIS (Geographic Information Systems).

Precision farming is based on the philosophy of heterogeneity within homogeneity and it requires precise information on the degree of variability to optimize input resources (Maheswari *et al.* 2008). Studies show that, out of total increase in the productivity of banana in precision farming over that of traditional farming, nearly two-third difference was due to the effect of precision farming technology and one-third the contribution of inputs use (Franco, 2013). Economic viability is one of the major concerns often raised by the farmers while adopting such new technologies (Narayanamoorthy, 1992). The major constraints faced by precision farmers in Tamil Nadu are categorized into three viz., technologies, marketing and others. Precision farmers felt that the technologies like drip irrigation, fertigation and chemical pesticides are expensive when compared to conventional farming (Rajeshkanna *et al.* 2008).

In Tamil Nadu, Theni district is the major district where farmers are cultivating banana under precision farming. Here precision farming was started during 2007-08. Theni district is in the southern part of Tamil Nadu. The climate of Theni district is conducive for banana cultivation. In Theni district, Grand Naine is the leading cultivar among the growers. It covers nearly 80-85 per cent of the area under banana cultivation and rest of the area is covered by Red Banana, Nendran and Monthan.

In precision farming of banana, farmers are following proper land preparation, drip and fertigation system, tissue culture (TC) plants, proper desuckering, proper weeding, timely application of fertilizers and manures, timely application of plant protection chemicals and growth regulators, timely irrigation, propping etc. So farmers are using farm resources efficiently. At the same time in conventional farming of banana, farmers are not using drip and fertigation system, TC plants, liquid fertilizers etc. Instead of that, farmers are following ordinary sucker plants, normal chemical fertilizers, improper land preparation, flood irrigation, improper desuckering and weeding, improper application of fertilizers and manures, plant protection chemicals and Growth Regulators, propping etc. Here, farm resources are not used much efficiently as compared to precision farming. But, while adopting precision farming in banana, farmers are also facing many constraints such as environmental, infrastructural, economical, technological, extension, administrative and social constraints; which hamper the pace of adoption. In this background, this study was conducted with the following specific objectives:

1. To assess the resource use efficiency of different farm inputs used in precision farming and conventional farming.
2. To study the constraints in adoption of precision farming in banana.

Methodology

The study was carried out in Tamil Nadu state of India. Primary data was collected using multistage sampling technique. Theni district has favourable climate for banana cultivation. Theni district was purposively selected due to the relatively higher concentration of the farmers involved in banana cultivation under precision farming and conventional farming. Among 8 blocks in Theni district, Chinnamanur block was purposively selected due to the relatively higher concentration of the farmers engaged in banana cultivation under precision farming and conventional farming. From Chinnamanur block, five villages were identified where most of the farmers are involved in banana cultivation under precision farming. From five selected villages, a list of farmers practicing precision farming as well as conventional farming was prepared and 40 farmers were randomly selected under precision farming and conventional farming. Thus, a total number of 80 farmers were interviewed.

Resource use efficiency of different farm inputs used in precision farming and conventional farming

Cobb- Douglas Production Function

Cobb- Douglas Production function was used to work out the productivity of key input factors used in production of banana crop.

Cobb- Douglas Production function is given as:

$$Y = aX_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4}$$

Where,

Y= Gross return per acre in ₹.

X_1= Human labour use per acre in ₹.

X_2 = Seed rate use (No. of tissue culture plants or suckers) per acre in ₹.

X_3= Cost of manures and fertilizers per acre in ₹.

X_4= Cost of plant protection chemicals per acre in ₹.

a- constant; b_1, b_2, b_3 and b_4 are elasticities of production for inputs X_1, X_2, X_3 and X_4, respectively.

Constraints in adoption of precision farming in banana

Garrett Ranking

Garrett's ranking technique was used for identifying the constraints in adoption of precision farming. Garrett's formula for converting ranks into per cent is given as:

$$\text{Percent position} = 100^*(R_{ij}-0.5)/N_j$$

where,

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

N_j = number of factors ranked by the j^{th} individual.

The per cent position of each rank was converted into scores referring to the table given by Garrett and Woodworth (1969). For each factor, the score of individual respondent is added together and divided by the total number of the respondents. These mean scores for all the factors are arranged and ranked in descending order to identify the important factors.

Results and Discussion

Resource use efficiency of different farm inputs used in precision farming and conventional farming

Table 1 represents resource use efficiency of different farm inputs used in precision farming and conventional farming. The value of R^2 in precision farming and conventional farming was 0.752 and 0.790, respectively, indicating that 75 per cent and 79 per cent of variations in the logarithmic value of gross returns per acre was attributable to the independent variables such as human labour, tissue culture plants/suckers, manures and fertilizers and plant protection chemicals.

The regression coefficient for the variable human labour turned to be positive in both the cases. The regression coefficient of human labour with positive sign in precision farming indicates that 1 per cent increase in human labour (₹/ac), would bring about an increase in gross return by 0.468 per cent, holding the other variable resources constant at their geometric mean levels. It was significant at 1 per cent probability level. The regression coefficient of human labour with positive sign in conventional farming indicates that 1 per cent increase in human labour (₹/ac), would bring about an increase in gross return by 0.352 per cent, holding the other variable resources constant at their geometric mean levels. It was significant at 10 per cent probability level. It represented that any increase in human labour would lead to increase in gross return in both the cases.

Table 1: Regression coefficients in precision farming and conventional farming of banana using Cobb-Douglas production function

Variables	Precision farming		Conventional farming	
	Coefficients	t-statistic	Coefficients	t-statistic
Intercept	-2.223	-1.365	-2.858	-1.673
Human labour (₹/ac)	0.468***	2.843	0.352*	1.984
Tissue culture plants / suckers (₹/ac)	0.359***	3.275	0.695***	3.959
Manures and fertilizers (₹/ac)	0.330***	2.784	0.363**	2.550
Plant protection chemicals (₹/ac)	0.421***	3.517	0.221**	2.109
R^2	0.752		0.790	
Adjusted R^2	0.724		0.766	
F ratio	26.566		32.981	
F sig	0.000		0.000	

*** 1% Significance, **5% Significance,*10% Significance.

The regression coefficient for the variable tissue culture plant was significant and positive for both precision farming and conventional farming, Which means that 1 percent increase in tissue culture plants would bring about increase in returns by 0.359 percent and 0.695 percent in precision farming and conventional farming respectively, holding the other variable resources constant at their geometric mean levels. It indicated that any increase in tissue culture plants/suckers would lead to increase in gross return in both the cases.

The regression coefficient for the variable manures and fertilizers was positive in both precision farming and conventional farming. It was significant at 1 per cent and 5 per cent probability level in precision and conventional farming, respectively. The regression coefficient of manures and fertilizers with positive sign in precision farming indicates that 1 per cent increase in manures and fertilizers (₹/ac), would bring about an increase in gross return by 0.330 per cent holding the other variable resources constant at their geometric mean levels. The regression coefficient of manures and fertilizers with positive sign in conventional farming indicates that 1 per cent increase in manures and fertilizers (₹/ac), would bring about an increase in gross return by 0.363 per cent holding the other variable resources constant at their geometric mean levels. It represented that any manures and fertilizers would lead to increase in gross return in both the cases.

The regression coefficient for the variable plant protection chemicals turned to be positive in both precision farming and conventional farming. It was significant at 1 per cent and 5 per cent probability level in precision and conventional farming, respectively. The regression coefficient of plant protection chemicals with positive sign in precision farming indicates that 1 per cent increase in plant protection chemicals (₹/ac), would bring about an increase in gross return by 0.421 per cent holding the other variable resources constant at their geometric mean levels. The regression coefficient of plant protection chemicals with positive sign in conventional farming indicates that 1 per cent increase in plant protection chemicals (₹/ac), would bring about an increase in gross return by 0.221 per cent holding the other variable resources constant at their geometric mean levels. It showed that use of plant protection chemicals would lead to increase in gross return in both the cases.

Constraints in adoption of precision farming in banana

Table 2 reveals the constraints in the adoption of precision farming. The ranking was done for different categories of constraints using Garret's ranking technique. Following Franco, 2013, the constraints were categorized into environmental, infrastructural, economic, technological, extension, administrative and social constraints. It was observed from the farmers that heavy wind, drought and pest attack were the major environmental constraints in adoption of precision farming. Their Garrett's scores were 71.70, 69.63 and 58.18, respectively. It was also observed that among infrastructural constraints, problems in power supply, lack of marketing facilities and transportation problems were identified as major constraints and their Garrett's scores were 74.80, 55.75 and 53.40, respectively.

Table 2: Constraints in adoption of precision farming

Constraints	Garrett's Score	Rank
1. Environmental constraints:		
Heavy wind	71.70	1
Drought	69.63	2
Pest attack	58.18	3
Drainage problem	44.25	4
High rainfall	42.40	5
High temperature	36.40	6
Excessive soil erosion	27.45	7
2. Infrastructural constraints		
Problems in power supply	74.80	1
Lack of marketing facilities	55.75	2
Transportation problems	53.40	3
Lack of credit availability	49.78	4
Lack of packaging facility	42.58	5
Lack of storage facility	23.70	6
3. Economic constraints		
High cost of drip and fertigation system	74.13	1
High cost of inputs	70.88	2
Price instability	56.48	3
Lack of insurance coverage	46.90	4
High wage rate	34.50	5
Market glut	33.93	6
Lack of contractual agreements	33.20	7
4. Technological constraints		
Non availability of skilled labour	74.20	1
Non availability of quality inputs	55.98	2
Non availability of implements	53.45	3
Heterogeneity of cropping system	48.20	4
Complexity of tools	36.18	5
Small farms	32.00	6
5. Extension constraints		
Lack of technical expertise	62.88	1
Lack of resource persons	60.75	2
Timely unavailability of weather data	51.38	3
Inadequate motivation from officials	45.38	4
Lack of demonstration farm	29.63	5
6. Administrative constraints		
Improper price policies	65.68	1
Lack of support from Krishi Bhawan	49.05	2
Red tapism	35.28	3
7. Social constraints		
Lack of self-confidence	60.93	1
Fear of failure	53.80	2
Lack of support from society	35.28	3

The farmers further ranked the high cost of drip and fertigation system, high input cost and price instability as the major economic constraints. Their Garrett's score were 74.13, 70.88 and 56.48, respectively. The nonavailability of skilled labour and non availability of quality inputs were ranked as the top technological constraints to the adoption of precision farming. The lack of technical expertise and resource persons were the extension constraints in adoption of precision farming. Improper price policies and lack of support from agriculture department were the major administrative constraints with Garrett's scores 65.68 and 49.05, respectively. In case of social constraints, the lack of self confidence and fear of failure in the farmers were ranked as the major constraints. Their Garrett's scores were 60.93 and 53.80, respectively. Even though precision farmers are getting more income as compared to conventional farmers, precision farmers are facing many constraints as explained above.

Conclusion

This paper attempts to study the resource use efficiency of different farm inputs used in precision farming and conventional farming as well as constraints in adoption of precision farming in banana. The regression coefficients for human labour in precision farming as well as in conventional farming were found to be positive and significant. So, there is scope to increase the human labour which will enhance the yield as well as employment. The regression coefficients for tissue culture (TC) plants/suckers in precision farming as well as in conventional farming were found to be positive and significant. So, there is scope to increase the TC plants/suckers which will enhance yield/income. The regression coefficients for manures and fertilizers in precision farming as well as in conventional farming were found to be positive and significant. It indicates that there is scope to increase the use of manures and fertilizers to maintain and increase the yield and soil fertility. The regression coefficients for plant protection chemicals in both the cases were found to be positive and significant. So, there is scope to increase the use of plant protection chemicals in order to get more yield from banana crop. Thus, on the basis of above results, it can be concluded that inputs use could be increased in order to get maximum return in both the cases.

The results also reveal that the problems in power supply, lack of marketing facilities were major infrastructural constraints. So, Government interventions are required to solve power supply problems by investing more on power projects and to make arrangements for marketing facilities. The high cost of drip and fertigation system, high input cost and price instability were the major economic constraints. So, there is need for financial assistance to farmers from the State Government and effective measures to check price instability. The lack of technical expertise and resource persons were the extension constraints in adoption of precision farming. The improper price policies and lack of support from agriculture department were the leading administrative constraints. Government policies as well as rational decisions from farmers are much needed to overcome these constraints.

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