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An Economic Assessment of Cotton Production under Precision Farming in North Eastern Karnataka

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ABSTRACT

Precision Farming is an old traditional farming in the modern way, which involves optimizing agricultural production by improving the precision of the existing agronomic management activities by implementing them at a subfield scale. Such an experimental implementation has been done in Karnataka as the project on precision farming in selected field crops. Hence, to analyze the economic benefits of precision farming in comparison with conventional farming the present study was undertaken. The study was conducted at Raichur district, Karnataka. The data were collected by personal interview method by the pretested schedule. The study results indicated that though the cost of cultivation was marginally higher (1.47 %) in precision farming than non-precision farming, the yield obtained under management practices of precision farming (38.03 q/ha) were much higher than (26.48 q/ha) conventional farming situations. Hence there was a net gain of ₹ 35,898.82/ha under the adoption of precision farming. Returns per rupee spent was 2.03. Considering its benefits there is a need to encourage and popularize this technology with the support of line departments, SAU's and other extension agencies.

Keywords: Precision farming, conventional farming, schedule, cost, returns, net gain

The agriculture sector has evolved from being a basic food gathering (hunting and fishing) activity to an intensive production system due to population growth, increase in income, urbanization, technological revolution, and liberalization of international trade. The long-term development process indicates to begin with the agricultural sector that accounts for the bulk of the country's economic output and a large share of the labour force. Growth in the overall economy depends on the development of the agriculture sector (Schultz, 1964). India has moved from an era of chronic food shortage during the 1960s to food self-sufficiency and even food exports from the 1990s. Demand for food and agriculture commodities in India is rising at a much higher rate than the growth in population of the country. Hence, with the sole pursuit of high productivity in order to meet the ever growing demand for the agricultural products, it has resulted in indiscriminating the utilization of resources which in turn resulted in neglecting the critical linkage between agriculture and environment and has posed a threat to the future of Indian agriculture on sustainable basis.

There are many risks that are impacting our ability to generate food today including plateauing crop yields in some regions, climate change and the increase in population growth. Currently, agriculture production is facing significant challenges such as escalating costs of production, shortage of irrigation water and increased public concern about the impacts of agricultural production on the environment. The focus on enhancing the productivity during the green revolution coupled with total disregard of proper management of inputs without considering the ecological impacts has resulted in environmental degradation (Singh, 2010). The idea of increasing crop yields using scientific method dates back to at least the 1730s. Since then, there have been many other scientific developments in agriculture including the application of synthetic fertilizers and growing plants using hydroponics and in recent

decades enabling development and the infusion of appropriate technologies. This concept envisages precision farming.

According to Robert *et al.* (1995), precision farming is defined as information and technology based agricultural management system to identify, analyze and manage site-soil, spatial and temporal variability within fields for optimum profitability, sustainability and protection of the environment. The biggest benefit of precision farming is that it gives producers the ability to manage their farm on a production zone basis rather than a whole field basis. This shift allows farmers to save time and money and helps them offset the rising cost of chemicals, nutrients, fuel and fertilizer (Subrata and Atanu, 2013). In recent days, there are a number of innovations that are contributing greatly to a concept called precision farming. Satellites, drones and even self-driving tractors with precision seeders are changing the way farmers are producing crops.

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. The technology has also been currently implemented in Karnataka under the RKVY funded project on precision farming in selected field crops since 2011.

The project was implemented by three State Agricultural Universities in the state with UAS, Raichur as the leading centre to guide the other two Agricultural Universities of the state 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 the major field crops of the North-Eastern Karnataka zone (Patil *et al.* 2013). With this backdrop, an attempt has been made in the present paper to analyze the comparative economics of cultivation of cotton under precision and non-precision farming situations.

In effect, the spatial variability in field is managed by the manipulation of inputs such as fertilizers, pesticides etc. Precision farming enables the farmer to reap increased profit through better management and the application of more appropriate/reduced chemical treatments also help to preserve the environment.

Methodology

The study was conducted in Karnataka with a focus on the North Eastern Karnataka region in the jurisdiction of UAS, Raichur. However, the study confined to Marchethal village of Raichur district of North Eastern Karnataka as RKVY-Precision Farming project for cotton crop has been implemented in this district. The precision farming adopted farmers refer to those who are the beneficiaries of precision farming project of UAS, Raichur. The precision farming non-adopted farmers refer to those who had not participated in precision farming but had been growing the same crop in the same area. The number of farmers who adopted precision farming for cotton were seven. Those farmers utilized the assistance from the University project. An equal number of non-adopted farmers were selected on the same criterion. Primary data were collected from the farmers who adopted precision farming techniques in cotton since last three years and also from the conventional farmers with the help of pre-tested interview schedule. The data were collected from the sample farmers by personal interview method during the period of January and February for the agricultural year 2014-15.

This technique of tabular presentation was employed to assess the cost, returns and profits of cotton under both precision and non-precision farming. The data were summarized with the aid of statistical tools like percentage, averages etc. to draw meaningful inferences. Partial budgeting is one of the basic tools in all the farm management decision making. In order to compare the costs and returns of precision and non-precision farming, partial budgeting technique was employed. This will reflect the difference in the quantitative aspects of precision and non-precision farming. A partial budget model was constructed by considering all revenue and the expenses that would change with an alteration to the farm operation. In the present study, the components like increase in costs and decrease in returns where on the debit side. While, decrease in costs and increase in returns were taken on the credit side. If the difference in credit and debit side

is positive, it is considered as net gain and if it is negative, it is considered as net loss.

RESULTS AND DISCUSSION

The results of the pattern and the extent of input usage under precision and non-precision cultivation of cotton were presented in Table 1. A glance at the table indicated that precision farming practicing farmers were found to use more quantity of all the inputs respectively than that of the farmers under non-precision farming. Among the chemical fertilizers, it was interesting to note that under precision farming, farmers have used more quantity of fertilizers i.e., N (18.74%), P_2O_5 (33.53%), K_2O (27.14%) and micronutrients (173.90%) than conventional farming. Application of fertilizers in precision farming was purely based on the soil testing report as the variable rate of the application of fertilizers was followed in precision farming. The farmers practicing precision farming have applied more fertilizers when compared to non-precision farming. Similar kind of observation was also made by Jarmila and Ladislav (2012). Their results suggested that the most overused input categories were fertilizers, chemicals and fuel.

However, in case of soils with better nutrient content, soil analysis report might show the examples of saving fertilizer by the farmers. As per the studies conducted by Synder (1996) and Ahmad *et al.* (1997) it can be concluded that there were savings with respect to the quantity of fertilizers application due to the variable rate of application when compared to the uniform application of fertilizers across the fields. Also, each operation in precision farming plots was carried out with the assistance of the project staff. Hence, more quantity of fertilizers has been applied based on the recommendation of the scientists by soil analysis report which was specified to that field variability.

Table 2 represents the labour cost incurred to carry out different operations in precision and non-precision cultivation of cotton. As the table represents, the cost incurred on labour to carry out various operations was found to be higher by 6.64 per cent in case of precision farming (₹ 37061.01/ha) when compared to non-precision farming (₹ 34753.56/ha). They have engaged more human labour to carry out all the operations when compared to non-precision farming. Since the input usage was higher in case of precision farming, conversely the mandays required for all the operations were observed to be more. Also, in precision farming the land preparation was specially made by nineteen cultivator under the assistance of the project. Hence, it represents more mandays for land preparation. Further, under precision farming, farmers used more number of human labour for the operations like grid soil sampling and laser leveling which were completely absent in non-precision farming. The usage of human labour to carry out picking and bagging operations was more under precision farming when compared to non-precision farming, which was due to the higher yields in precision farming.

The cost of cultivation per hectare was marginally higher (1.47 %) in precision farming when compared to non-precision farming (Table 3). Further, the labour cost was more in precision farming (6.64%) when compared to non-precision farming. Whereas, the material cost accounted to be higher in non-

Table 1: Comparative material input use pattern in precision and non-precision cultivation of cotton

Sl. No.	Particulars	Units	Precision farming	Non-precision farming	% change
1	Seeds	kg/ha	2.25	2.23	0.90
2	Organic manures	t/ha	4.23	3.92	7.91
3	**Fertilizers**				
a)	N	kg/ha	368.72	310.54	18.74
b)	P_2O_5	kg/ha	200.45	150.12	33.53
c)	K_2O	kg/ha	280.62	220.72	27.14
d)	Micronutrients	kg/ha	28.76	10.50	173.90

precision farming (39.31%) when compared to precision farming (37.16%). In case of non-precision farming, higher cost was incurred on PPC (₹ 11688.91/ha) which represents the saving made by precision farming practicing farmers to the tune of 26.74 per cent. This was because of the application of PPC based on the requirement as per grids. Of the total cost of cultivation, the material cost accounted for 37 to 39 per cent and the labour cost for 42 to 44 per cent in both the farming methods. Thus, the total variable cost accounted line share in the total cost of cultivation under both precision as well as non-precision farming (90.25 to 90.23 %).These results were in similarity with Maheswari *et al.* (2008), who reported that 42.15 per cent of total variable cost was incurred by farmers under precision farming when compared to the farmers under non-precision farming in tomato production.

Table 2: Operation-wise labour cost in precision and non-precision cultivation of cotton (₹/ha)

Sl. No.	Operations	Precision farming	Non-Precision farming	% change
1	Ploughing	7665.00	7089.00	8.13
2	Harrowing	641.00	1084.00	-40.87
3	Soil sampling	862.50	—	—
4	Laser levelling	1019.00	—	—
5	Application of manures	885.00	780.00	13.46
6	Sowing	2552.50	2580.56	-1.09
7	Gap filling	1075.00	987.50	8.86
8	Application of fertilizers	2552.50	2420.00	5.48
9	Hand weeding	3307.51	3940.00	-16.05
10	Intercultivation	1108.50	1072.50	3.36
11	Application of PPC	2440.00	3127.50	-21.98
12	Application of growth hormones	435.00	312.50	39.20
13	Picking and bagging	12517.50	11360.00	10.19
Total		**37061.01**	**34753.56**	**6.64**

In the total fixed cost, land rent (₹ 6250.00/ha) occupied the major share. The depreciation cost was found to be higher (12.29 %) in case of precision farming when compared to non-precision farming. The reason was quite obvious because almost all the precision farming participant farmers were large farmers when compared to the farmers under non-precision farming. Hence, precision farming practicing farmers own all the equipment which accounts for higher depreciation cost.

It was evident from Table 4 that, though the precision farming practicing farmers incurred a total cost of 1.47 per cent more than that of the farmers under non-precision farming, there was a considerable difference in yield from precision (38.03 q/ha) to non-precision farming (26.48 q/ha) due to better management practices followed under precision farming. Hence, the gross returns obtained by the precision farming practicing farmers (₹ 168020.50/ ha) was 28.14 per cent more than that of the non-participants of precision farming (₹ 131120.51/ha). Similarly, study conducted by Maheswari *et al.* (2008) quoted in their study that precision farming has led to 80 per cent increase in yield in tomato and 34 per cent in brinjal production. Increase in gross margin has been found to be 165 and 67 per cent, respectively in tomato and brinjal farming.

Hence, returns per rupee spent were higher in precision farming (2.03) when compared to non-precision farming (1.61).This indicated that by spending one rupee, 2.03 rupees of returns can be generated in case of precision farming and 1.61 rupees in non-precision farming. These results were in line with the results quoted by Snyder (1996) and Thomas (2006). They indicated that the BC ratio was more than one in precision farming operating firm.

The method of partial budgeting was carried out to assess the net gain or loss due to the adoption of precision farming technology over non-precision farming and the results were presented in Table 5. Though majority of the inputs contributed to an increase in costs (debit), the decrease in costs (credit) was mainly for PPC and labour cost incurred for the operations like harrowing, sowing, hand weeding and the application of PPC. Decrease in returns was nil. Increase in returns due to precision farming was found to be ₹ 36,899.99/ ha and there was a net gain of ₹ 35,898.82/ha under precision farming over non-precision farming. Similar result was reported by Swinton and Lownberg-DeBorer (1998). They showed that the average benefit of precision farming over three years was about 15 bushels/ac.

Table 3: Comparative cost of cultivation of cotton under precision and non-precision farming (₹/ha)

Sl. No.	Particulars	Precision farming	Non-precision farming	% change
A.	**Material input cost**			
	Seeds	4750.12 (5.74)	4707.90 (5.78)	0.90
	Organic manures	1296.00 (1.57)	1176.00 (1.44)	10.20
	Chemical fertilizers	15876.33 (19.20)	14242.50 (17.47)	11.47
	Plant protection chemicals	8562.84 (10.35)	11688.91 (14.34)	-26.74
	Growth hormones	248.74 (0.30)	225.00 (0.28)	10.55
	Sub total	**30734.03 (37.16)**	**32040.31 (39.31)**	**-4.08**
B.	Labour cost	37061.01 (44.81)	34753.56 (42.63)	6.64
C.	Marketing cost	685.55 (0.83)	685.55 (0.84)	0.00
D.	Interest on working capital @ 9%	6163.25 (7.45)	6073.15 (7.45)	1.48
E.	Total variable cost (A+B+C+D)	74643.85 (90.25)	73552.57 (90.23)	1.48
1	Depreciation	850.00 (1.03)	757.00 (0.93)	12.29
2	Land rent	6250.00 (7.56)	6250.00 (7.67)	0.00
3	Land revenue	150.00 (0.18)	150.00 (0.18)	0.00
4	Interest on fixed capital @ 11.25%	815.63 (0.99)	805.16 (0.99)	1.30
F.	Total fixed cost (1+2+3+4)	8065.63 (9.75)	7962.16 (9.77)	1.30
	Total cost (E+F)	**82709.47** (**100.00**)	81514.73 (**100.00**)	1.47

Note: *Figures in the parentheses indicate percentage to total cost.*

Table 4: Cost and returns structure of cotton under precision and non-precision farming conditions (₹/ha)

Sl. No.	Particulars	Precision farming	Non-precision farming	% change
1	Total variable cost	74643.85	73552.57	1.48
2	Total fixed cost	8065.62	7962.16	1.30
3	Total cost	82709.47	81514.73	1.47
4	Yield(q)	38.03	26.48	43.62
5	Gross returns	168020.50	131120.51	28.14
6	Net returns	85311.03	49605.78	71.98
7	Returns per rupee spent	2.03	1.61	

Table 5: Assessment of net gain or loss in precision farming over non-precision farming of cotton through partial budgeting approach (₹/ha)

Precision farming over Non precision farming				
	Debit	**₹/ha**	**Credit**	**₹/ha**
Sl. No.	**A. Increase in costs**		**C. Decrease in costs**	
1	Seeds	42.22	Plant protection chemicals	3126.07
2	Organic manures	120.00	Harrowing	443.00
3	Chemical fertilizers	1633.83	Sowing	28.06
4	Growth hormones/ regulators	23.74	Hand weeding	632.49
5	Ploughing	576.00	Application of PPC	687.50
6	Soil sampling	862.50		
7	Laser levelling	1019.00		

8	Application of manures	105.00		
9	Gap filling	87.50		
10	Application of fertilizers	132.50		
11	Intercultivation	36.00		
12	Application of growth hormones	122.50		
13	Picking and bagging	1157.50		
	B. Decrease in returns	NIL	D. Increase in return	36899.99
	Total (A+B)	5918.29	Total (C+D)	41817.11

Net gain [(C+D)-(A+B)] = (41817.11-5918.29) = ₹ 35898.82/-

CONCLUSION

Precision farming helps in dealing with the challenge of variability of soil type and structure over short distances by proper and effective management of soil and crop variability with the use of information technology. Precision farming is "doing the right thing, at the right place, at the right time". From the study it was found that farmers under precision farming were aware about precision farming practices. They were aware of in-filed variability and hence knew the management of the crop as per the grids. Thus, it's evident that though the cost of cultivation was higher in precision farming, the farmers under precision farming have realized more returns than the non-participants. The study has revealed that the farmers were benefited due to the adoption of precision farming when compared to non-adopters. It was observed that the farmers under non-precision farming were applying inputs like fertilizers and PPCs without the knowledge of infield variability with the misconception of getting higher yields. This affects soil health. But, the knowledge regarding this was found among the precision farming practicing farmers because of the technical guidance by the project staff.

Generally the equipments used in precision farming are not affordable to the individual farmers in developing countries like India. But the initiation of precision farming does not compulsorily require sophisticated tools and equipments. Effective use of inputs and management practices considering infield variability also signifies precision farming. However, there is possibility of investing in the required equipments through the collectivisation of the farmers. The awareness about precision farming practices and its benefit are lacking among the non-participants. Hence there is a need to encourage and popularize this technology with the support of line departments, SAU's and other extension agencies.

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