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Financial Feasibility of Precision Farming in Paddy- A Case Study

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Abstract

Precision farming is an emerging, highly promising technology that helps in dealing with the present agricultural challenges by proper and effective management of soil and crop variability with the use of information technology. In order to initiate precision farming in India through state agricultural universities, the precision farming project in selected field crops was implemented in University of Agricultural Sciences, Raichur, Karnataka. The objective of the study was to assess the financial feasibility of project implementation at farm level in paddy. Primary data was collected with the aid of a well-structured, pre tested schedule. Findings showed that the project of precision farming in paddy which was implemented by the University was economically viable and financially feasible. The cost incurred in cultivation of paddy by adopting precision farming practices was ₹75,825.35/ha and gross returns were ₹ 1,22,656.30/ha. Results of financial feasibility measures showed that the Net Present Value at 12 per cent discount rate, at the end of ten years was found to be positive, Benefit-Cost ratio was more than one and Internal Rate of Returns of the precision farming in paddy was more than discount rate (12%). It was also revealed that payback period was 6.84 months and profitability index due to adoption of precision farming was found to be 8.83. Hence it was concluded that investment on precision farming in paddy at farm level was feasible to operate at farm level with the technical assistance from University. Considering the adoption strategy of precision farming and its benefits, there is a need to bring awareness among farming community by the joint effort of public and private sectors through the extension agencies, non-governmental organizations and state agricultural universities.

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Introduction

The agriculture, as the primary sector in most developing nations of the world play a significant role for the development and growth of nations. Successful agricultural transformation in agriculture has took place around the world from subsistence

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to commercialized or from traditional to modernized agriculture, largely attributed to improved farm technologies such as use of high yielding varieties, improved seeds, fertilizer and soil and water conservation1. Further, to meet the huge projected food grain requirement in India by the year 2050 of 480 million tonnes, with the challenges like increased cost of production, increasing biotic and abiotic stresses experienced by crops, introduction of technology in Indian agriculture and adoption of modern technology is inevitable 2&3. Indian agriculture is in need of not only the resource based technologies but also the knowledge based technologies with the perspective of financially feasibility.

Precision farming (PF) is such an emerging and promising technology for optimum utilization of resources. PF is a concept of management in farm which relies on observing, measuring and responding to inter and intra-field variability in crop fields. The purpose is to vary the agricultural inputs in response to field variability. PF is also known as prescription farming as Variable Rate Technology and Site Specific Crop Management. Precision farming can be 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 environment4. Precision agriculture is doing the right thing, in the right place at the right time.

Though the concept of precision farming is old in developed countries, the adoption of it in developing countries like India is at primitive infancy stage. The initiative of precision farming in India through various projects under both agriculture and horticulture has been done in various institutes and research organizations. Agricultural institutes such as Indian Agricultural Research Institutes (IARI), drawn up plans to conduct precision agriculture experiments in the institute's farm through State Agricultural Universities (SAUs).

The precision farming technology has been currently implemented in 2011-12 at SAUs of Karnataka state as precision farming in selected field crops which was funded under the Rashtriya Krishi Vikas Yojana (RKVY). 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, Raichur5. The objective of present study is to evaluate the economic viability and financial feasibility of PF adoption in paddy.

Significance of Study

To reach the potential productivity, mechanization and technology implications in Indian agriculture are must. Tireless efforts of scientists and researchers will result in improper utilization of time and resources at the farm, since the farmers have not planned for adoption of strategic long term technologies. Precision farming is not impossible to adopt in developing countries, but efforts are needed from government and scientists to find out its applicability in the Indian agricultural scenario. Application of precision farming techniques in field crops was first of its kind in India and was adopted in UAS, Raichur jurisdiction with RKVY fund in farmers' field. Any project subjected to evaluation by financial measures can be visualized with the meaningful conclusions and adoptability over time. Hence, the present study will be a modest attempt to examine the economic feasibility of precision farming adoption at the farm level in India. Thus, an attempt has been made through present paper to analyze the feasibility by considering paddy crop.

Methodology

The study was conducted in North Eastern Karnataka region of Karnataka state in the jurisdiction of UAS, Raichur. However, the study area confined to village Jangamarakalgudi of Gangavathitaluk, Koppal district of North Eastern Karnataka as RKVY- Precision Farming project for paddy has been implemented in that district. The sample farmers under study for the present paper includes only the precision farming adopted farmers (the beneficiaries of precision farming project of UAS, Raichur). The

number of farmers who adopted precision farming for paddy was 38. Primary data were collected from the farmers who adopted precision farming techniques in paddy since last three years. 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.

The data collected were analyzed by using tabular analysis as well as financial feasibility measures. The technique of tabular presentation was employed to assess the cost, returns and profits of paddy cultivation. The data were summarized with the aid of statistical tools like percentage, averages etc. to draw meaningful inferences. To evaluate the economic viability of an investment in precision farming techniques at the farm level, financial feasibility analysis was carried out by using following measures:

i. Net Present Value (NPV): The cash flow stream is weighted by the discount rate and then it becomes the discounted cash flows. The positive value of NPV is the criteria for selection of the project/ investment. NPV was estimated by using the formula,

$$NPV = \sum_{t=1}^{n} \frac{(B_t - C_t)}{(1+r)^n} - I$$

Where, Bt= Discounted benefits, Ct = Discounted costs, t = time period, r = discount rate, n= number of years, I= initial investment

ii. Benefit- Cost Ratio (B: C ratio): It attempts to identify the relationship between the costs and benefits of the project. It is the ratio of benefits of the project to the costs, expressed in monetary terms, which are discounted at

Table 1: Cost and returns structure in adoption of precision farming in paddy

Sl. no.	Particulars	Amount (₹/ha)	Percentage contribution to total cost (₹/ha)
	COST		
I	Total variable cost		
1	Material input cost	15904.97	20.98
2	Labour cost	39115.62	51.59
3	Marketing cost	805.86	1.06
4	Interest on working capital @9%	5024.38	6.63
	Sub total	60850.83	80.25
II	Total fixed cost		
1	Depreciation	792.71	1.05
2	Land rent	10875	14.34
3	Land revenue	175	0.23
4	Interest on fixed capital @11.25%	1332.3	1.76
	Sub total	13175.01	17.38
A	Total cost of cultivation(I+II)	74025.84	97.63
B	Management cost	1799.51	2.37
	Total cost (A+B)	75825.35	100
	RETURNS/ REVENUE		
1	Yield (q)	75.55	-
2	Gross returns	122656.3	-

the present value. The criteria for preferred project is B: C ratio of more than unity when costs and benefits were discounted at the opportunity cost of capital

iii. Internal Rate of Return (IRR): It is the discount rate which makes NPV of all the cash flows from the particular project is equal to zero. It was calculated by interpolation technique by using the formula,

$$\text{IRR} = \text{Lower discount rate} + \left(\frac{\text{NPV at lower discount rate}}{\text{Difference between NPV at discount rates)}} \right) \text{X (difference between two discount rates}$$

iv. Payback period (P): It is the length of time required for the investment to recover its initial investment made in the project. It was estimated by ratio of investment of the project to annual net cash revenues

v. Profitability index (PI): It is the investment appraisal technique calculated as the ratio of present value of future cash flows to the initial investment of the project.

Assumptions of Study

- Useful life of the equipments used was assumed as ten years.
- Area under cultivation in paddy was assumed to remain same up to ten years.
- The benefits from the precision farming technology will be realized from the very first year of implementation of the technology.
- Technology remains constant over the time period.
- Discount rate of 12 per cent was assumed as the opportunity cost of capital at which stream of cash flow is discounted.
- The costs and the gross returns were assumed to be unchanged from first to tenth year.

Results and Discussion

There were two cost components involved in adoption of precision farming in paddy viz., the cost of cultivation and the maintenance cost. These are recurring in nature. The details regarding these costs were presented in table 1. The total cost of cultivation of paddy incurred in precision farming adopted farm was ₹ 75825.35/ha. These included the total variable cost (₹60850.83/ha) and fixed cost (₹13175.01/ha) components.

Variable costs had occupied the crunch share in total cost of 80.25 per cent. Whereas, fixed cost had 17.38 per cent share to the total cost, which included costs of depreciation, land rent, land revenue and interest on fixed capital. There was an additional cost component called management cost which had its share of 2.37 per cent to total cost, has been accounted which included the per hectare cost of soil analysis and per hectare grid making charges

Table 2: Cash-flow streams in paddy (₹)

Year	Cash outflow	Cash inflow	Net cash flow	Discount factor @12%	Current value	Discounted costs	Discounted benefits
0	26906.55		-26906.5	1	-26906.55	26906.55	
1	75825.35	122656.3	46830.95	0.89	41813.35	67701.21	109514.55
2	75825.35	122656.3	46830.95	0.79	37333.35	60447.5	97780.85
3	75825.35	122656.3	46830.95	0.71	33333.35	53970.99	87304.33
4	75825.35	122656.3	46830.95	0.63	29761.92	48188.38	77950.3
5	75825.35	122656.3	46830.95	0.56	26573.14	43025.34	69598.48
6	75825.35	122656.3	46830.95	0.5	23726.02	38415.48	62141.5
7	75825.35	122656.3	46830.95	0.45	21183.94	34299.54	55483.48
8	75825.35	122656.3	46830.95	0.4	18914.24	30624.59	49538.82
9	75825.35	122656.3	46830.95	0.36	16887.71	27343.38	44231.09
10	75825.35	122656.3	46830.95	0.32	15078.31	24413.73	39492.05

summed up to ₹ 1799.51/ha. These costs took as an additional component because these operations were compulsorily undertaken in precision farming adopted fields for every year. Further, all the crop management operations were took place as per grids. Thus, the total cost (₹75825.35/ha) in adopting technology included total cost of cultivation (97.63%) and the management cost (2.37%). The yield obtained in paddy by adopting precision farming was 75.55 q/ha (Table 1). The total returns obtained was ₹ 122656.30/ha. These results were in line with previous study conducted on economic analysis of precision farming in vegetables at Tamil Nadu. The results indicated 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 as 165 and 67 per cent, respectively in tomato and brinjal farming[6].

By accounting these costs, the cash flow stream was constructed by assuming ten years of economic life of project. Cash flow stream of paddy cultivation was constructed by using annual stream of gross benefits, initial capital invested and the stream of costs incurred over the each time period and presented in table 2. The cost at the zero represents the establishment cost (₹ 26905.55/ha), which was calculated by sum of all fixed costs on equipments like Differential Global Positioning System (DGPS), Green seekers, SPAD chlorophylimeter, Crop sensor, Leaf Area Index (LAI) meter and Screw auger, which were used in precision farming at the farm level by the assistance of project. This cost was apportioned for one hectare of paddy as the cost on these equipments was spread over for 100 hectares. The maintenance cost and gross returns were ₹ 75,825.35/ha and ₹ 122656.30/ha from first to tenth year, respectively. These costs and returns were discounted at the 12 per cent opportunity cost of capital thereby discounted costs and discounted benefits were calculated.

Table 3: Financial feasibility measures of paddy

Sl. no.	Particulars	Values
1	NPV (₹)	237698.76
2	B: C	1.52
3	IRR (%)	70.54
4	Payback period (Months)	6.84
5	Profitability index	8.83

The evaluation criteria of the investment on precision farming were NPV, B: C ratio, IRR, payback period and profitability index. The estimated financial feasibility measures of paddy were presented in table 3. Accordingly, The NPV at 12 per cent discount rate, at the end of ten years was found to be positive (₹237698.76). This indicated that the investment made in the technology was financially feasible and the project implemented by the University was economically viable. Also, the farmers would earn ₹ 2,37,698.76 after ten years from the present investment on precision farming. B: C ratio, which indicated net returns realized per rupee of investment was observed to be 1.58, which is more than one. This indicated that the investment in precision farming is financially sound. IRR has been considered as the important and it scores over the criteria of evaluation of project, which do not consider the reinvestment opportunities. IRR of the precision farming in paddy was more than 12 per cent (70.54%), which clearly indicated that investment on precision farming at farm level was profitable.

Payback period is the true period required to repay the loans borrowed. From the table 3 it could be noted that at 12 per cent discount rate the time period required to repay loan amount was 6.84 months. Hence, it was interesting to note that the loans can be repaid within shorter time period. Profitability index due to adoption of precision farming was found to be 8.83.

The obtained results in the present study were in consonance with the previous studies which were conducted to analyze the feasibility of precision farming. A study conducted at Kansas State University reported that B: C ratio was more than one7. Profitability from an investment in precision farming was arrived through calculation NPV and reported that, accumulated net present value at the end of 10 years was ($ 275) positive[8]. Similarly, the results were in line with the study conducted at Kentucky, where it was reported that precision farming firm could operate successfully with a

payback period of three years, positive NPV $ 37,971, 1.27 B: C ratio and 11 per cent IRR which indicated the project was feasible 9.

Further, in another previous study conducted on uncertainty and investment in precision farming by employing real options analysis reported that the eNPV (Expected NPV) increased above the non-stochastic NPV between 64 per cent to 190 per cent10. Overall, it was indicated that the project implemented by the University was economically viable and financially feasible.

Conclusion

The results of present investigation concluded that the project of precision farming in paddy crop implemented by the University (UAS, Raichur) was economically viable and financially feasible. Since, all the criteria of project evaluation measures were met i.e., NPV was found positive, B: C ratio was more than one, IRR was more than discount rate and short term payback period. Generally, basic hinder in technological advancement in Indian agriculture is that many of the farm technologies including precision farming are at an infant stage and pricing of equipment and services is hard to pin down. It was observed that generally, the farmers under delusion that precision farming is only possible with high cost invested equipment and it involves more cost than conventional farming. But through the findings of the present study, it was observed that precision farming technology adoption is not the compulsory usage of high invested equipment or sophisticated tools. Though the high cost equipment like yield monitors were not used, PF can be initiated with low cost technologies and management practices like levelling, grid making, soil analysis, managing grid wise etc., Hence it is not the technology of developed nations, it is also feasible to adopt in developing countries like India.

Though there is cognizance of soil testing, optimum input use and other concepts of precision farming methods among some farmers, majority of the farmers are still not aware about precision farming. 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, 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, NGOs and SAUs by the joint effort of public and private sectors.

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