INSTITUTION OF AGRICULTURAL TECHNOLOGISTS,

BENGALURU

EVALUATION OF RKVY PROJECTS

OF

UNIVERSITY OF AGRICULTURAL SCIENCES,

RAICHUR

"PRECISION FARMING TECHNIQUES IN SELECTED FIELD CROPS"

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"PRECISION FARMING TECHNIQUES IN SELECTED FIELD CROPS"

EXECUTIVE SUMMARY

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 indiscriminate 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.

As the world's population grows, farmers will need to produce more and more food. Yet arable acreage cannot keep pace, and the looming food security threat could easily devolve into regional or even global instability. 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. Traditional farming relies on managing entire fields—making decisions related to planting, harvesting, irrigating, and applying pesticides and fertilizer—based on regional conditions and historical data.

Precision agriculture is the application of technologies and principles to manage spatial and temporal variability associated with all aspects of agricultural production for improving production and environmental quality. The success in precision agriculture depends on the accurate assessment of the variability, its management and evaluation in space-time continuum in crop production. The agronomic feasibility of precision agriculture has been intuitive, depending largely on the application of traditional management recommendations at finer scales. 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.

Though it is widely adopted in developed countries, the adoption of precision farming in India is yet to take a firm ground primarily.

Although India has made considerable advance in agricultural research, but still the blanket recommendations of fertilizers for adoption over larger areas are in vogue. These blanket recommendations are no more useful to enhance productivity gains, which were witnessed between 1960's and 1980's. Now, to enhance growth rate in productivity, precision agriculture technology has to be developed. Precision agriculture is important because of the following points:

i. nutrient variability within a field can be very high affecting optimum fertilizer rates
ii. yield potential and grain protein can also vary greatly even within one field, affecting fertilizer requirement
iii. increasing fertilizer use efficiency will become more important with increasing fertilizer costs and environment concerns
iv. irrigation at critical stages is very important and
v. pest and stress management at the early stages of the crop helps the farmer to get maximum yield

Popularization of soil test based nutrient application in other words optimum input application may save cost on inputs, improve quality of agriculture produce apart from addressing the environment pollution issues associated with over use of agricultural inputs particularly in irrigation commands which are obsessed with high input intensive practices.

Keeping this in view the project, "**PRECISION FARMING TECHNIQUES IN SELECTED FIELD CROPS**" was sanctioned under Rashtriya Krishi Vikas Yojane (RKVY) during 2010-11 to take up large scale demonstration at farmers' fields. The adoption of precision farming tools and techniques in selected field crops through large scale demonstrations were taken at different villages under farmers' participatory approach in Raichur, Gulbarga and Koppal districts, covering approximately an equivalent of 100 acres each in Cotton, Pigeon Pea and Paddy crops respectively during 2011-12, 2012-13, & 2013-14. Apart from this, research demonstration plots [5.00 acres in each crop] at different research stations [Kalaburgi, Raichur and Gangavathi] of University of Agricultural Sciences, Raichur were also undertaken to assess the feasibility of Precision Farming Techniques in small scale land holdings during these years. However, during the year 2014-15, only research demonstration plots [5.00 acres in each crop] at three different research stations of University of Agricultural Sciences, Raichur were undertaken owing to several constraints. Finally, Precision Farming techniques were demonstrated in large areas of farmers' fields accounting to a total of 92.49 Acres in Cotton in Merchatal village, Raichur taluk & district, 78.125 Acres in Paddy in Jangamara Kalgudi village, Gangavathi taluk, Koppal district and

137.48 Acres in Pigeon pea in Chinamgera (73.74 acres), Ingalgi (48.12 acres) and Chowdapur (15.62 acres) villages, Afzalpur taluk, Kalaburgi district under the RKVY sponsored project.

The details of the project were as under:

1.	**Title of Project**	**:**	"**PRECISION FARMING TECHNIQUES IN SELECTED FIELD CROPS**"
2.	**Nodal officer and Principal Investigator**	**:**	**Dr. M. B. Patil,** Professor of Plant Pathology, Head AEEC, Koppal **Dr. Veeresh H.**, Asst. Professor of Soil Science, College of Agriculture, University of Agricultural Sciences, Raichur (In charge PI) **Dr. Masthana Reddy**, Professor of Agronomy, Chief Scientist & Head, ARS, Gangavathi (Co-investigator) **Dr. Pandith Rathod**, Associate Professor of Agronomy, Senior Scientist, AICRP on Chickpea, ARS, Kalaburgi (Co-investigator)
3.	**Implementing Institution (S) and other collaborating Institution (s)**	**:**	College of Agriculture, Raichur, ZARS Raichur, ARS Kalaburgi, Gangavathi
4.	**Date of commencement of Project**	**:**	2010-11
5.	**Approved date of completion**	**:**	2015-16
6.	**Actual date of completion**	**:**	2015-16
7.	**Project cost**	**:**	Rs. 110 lakhs

The objectives of the project were to adopt and demonstrate precision farming techniques for cotton, pigeon pea and paddy crops by emphasizing soil test based nutrient application to optimize soil input application.

The focus of Evaluation is:

i. To study the impact of soil test based nutrient application on crop yield in different crops.
ii. To study the impact of demonstration of precision farming techniques for cotton, pigeon pea and paddy crops in farmers' fields.

iii. To study whether the farmers who have benefitted from demonstrations of precision farming techniques are able to obtain sustained production by following the recommendations of the project scientists.

iv. To study the constraints in successful implementation, adoption and popularization of Precision Farming Techniques from the point of Indian Scenario.

FINDINGS AND DISCUSSION

The studies in research plots at the research stations and in farmers' fields revealed that:

1. Farmers were following blanket fertilizer application of major nutrients without any assessment of the soil fertility status and specific crop requirement.
2. It was clearly evident from the data observed and recorded from the experimental plots either in research farms or in farmers' fields that spatial variability of many factors of soil and crop did exist.
3. Farmers are convinced that by adopting the practices such as soil test based input application can save the unnecessary cost on fertilizer inputs, timely management of pests as per standard package of practices can control pest and disease occurrence better in crops, intervention through amendments and foliar nutrition can fetch higher crop yields etc.
4. Paddy farmers in Gangavathi taluk and cotton farmers' in Afzalpur taluk were more enthusiastic as they have found significant reduction in application of inputs and apart from fetching higher crop yields.
5. Increase in yield of pigeon pea in farmers' fields coincided with shift in variety of pigeon pea grown from the native Guliyal variety to TS3R.
6. The participatory approach in adoption of precision farming techniques by farmers resulted in application of other nutrients like Zinc, Iron and Potassium in addition to Nitrogen and Phosphorus that the farmers were using before introduction of the techniques.

Farmers used to apply blanket application of fertilizers to the crop based on their own indigenous knowledge. After, the intervention of project implementing team

1. Farmers have understood that soil fertility differs from field to field as well as varies within a given field.
2. Blanket application may not be the best way of fertilizer application
3. Different crops require different quantum of application
4. Optimum dose of fertilizer application can be satisfactorily achieved by interpreting

soil testing results.

5. Fertilizer application after every irrigation is not a good practice
6. Higher application of fertilizer will not always fetch higher profit even though higher crop yields are realized.
7. Application of soil test based fertilizer ensured good crop stand, low pest and disease occurrence and saved the money on pesticides.
8. Standing crop can also be effectively monitored by using crop sensor observations.

As a whole, the large scale demonstrations at farmers' field under precision farming techniques were successful in building the confidence among the farmers about the techniques of modern agriculture. They are convinced that by adopting the practices such as soil test based input application can save the unnecessary cost on fertilizer inputs, timely management of pests as per standard package of practices can control pest and disease occurrence better in crops, intervention through amendments and foliar nutrition can fetch higher crop yields etc.

REFLECTIONS AND CONCLUSIONS

1. Although the title of the project indicates adoption of Precision Farming Techniques in selected field crops, the study was mostly confined to soil test based application of fertilizers with focus on major nutrients and to some extent zinc and iron. Precision farming involves the application of technologies and principles to manage spatial and temporal variability associated with all aspects of agricultural production for improving crop performance and environment quality. Precision farming calls for an efficient management of resources through location-specific hi-tech interventions. The advance crop production encompasses a variety of interventions such as micro irrigation, fertigation, protected greenhouse cultivation, soil and leaf nutrient-based fertilizer management, mulching moisture conservation, micro propagation, genetically-modified crops, use of bio fertilizers, vermin culture, high-density planting, hi-tech mechanization, green food, soil-less culture and biological control. The present study has, however, been confined to Soil Test Crop Response (STCR) as a major precision farming technique.
2. Grid based soil variability maps and variability zones for Soil pH, Soil Electrical Conductivity, Soil Nitrogen and Soil Phosphorus have been developed for the fields in the research stations and prescription maps for application of nitrogen as urea, phosphorus as Diammonium phosphate have been developed and application of fertilizers have been made according to soil variability maps. Similar grid based soil variability maps and variability zones for the nutrients for the various farmers' fields should have been made to educate the farmers on the need for site specific application of nutrients.

3. The results have indicated that there was an increase in yield by 15-20% in cotton, 20-25% in paddy and 15-25% in pigeon pea over the farmers' method and there was also significant reduction in the amount of fertilizer input consumption by 10 - 15% in cotton and 25-30% in paddy when compared to the farmers' method of fertilizer application during the previous years. The increase in yield on account of adoption of soil test based fertilizer application was more in research station experimental plots as compared to farmers' fields. While the exact reason for this variability was not evaluated, it may be due to higher soil variability in the grids and application of site specific nutrients in bigger grids of 50 m x 50 m in farmers' fields vis a vis 10 m x 10 m grids in research plots.
4. The experiments during 2014-15 at MARS, Raichur are affected due to the vagaries of climate, i.e., heavy rainfall on August 25th, 2014 and continued incessant rain afterwards that affected the crops so much that Pigeon pea experiment had to be discarded. On the other hand, the yield of cotton crop in both precision and non precision experimental plots was below the normal.
5. During 2015-16, the demonstration trials at Farmers' field on pigeon pea at different villages of Kalaburgi district were abandoned and the trials were discontinued owing to severe drought. Bt cotton yield from the farmers' demonstration fields undertaken at Raichur district was much below the targeted yield due to prevalence of drought like situations as well as severe attack of pink boll worm during the experimentation.
6. The adoption of grid based soil tests at yearly interval and application of test based nutrients were found to be tedious and time consuming. Better precision farming techniques like use of satellite data, use of tractor mounted or hand held sensors could reduce the drudgery of the work. In recent days, there are a number of innovations that are contributing greatly to the concept of precision farming. Satellites, drones and even self-driven tractors with precision seeders are changing the way farmers are producing crops.
7. Inadequacy of plant growth observations on all the three crops studied was observed and hence scientific reasoning for the achievements are not given.
8. The economics and production and impact of technology on the productivity are missing.

ACTION POINTS

1. While commendable work has been done by the project coordinators in educating the farmers to adopt precision farming techniques for site specific application of nutrients, wide climatic and soil type variability are observed within the area of operation of the University for the same crops. Systematic study of the precision farming techniques for the same crop in different soils and climates could give interesting information on adoption of these techniques.

2. The precision farming techniques in farmers' fields were supervised by the project coordinators during the project period. After the project was completed, there does not appear to have been any follow up visits by project coordinators except in Kalaburgi district. As a result, most of the farmers have gone back to the traditional practice of blanket application of fertilizers. Grid based soil tests have not been done after the project period was over. Only in Gangavathi, general soil test was done for one year. Thereafter, no soil tests have been done. The purpose of educating the farmers for adopting the techniques has been lost as the practice has been abandoned. Follow up visits could have ensured continuation of adoption with better results.
3. Interaction with pigeon pea farmers at Chimagera in Afzalpur taluk and paddy farmers at Jangamara Kalgudi revealed that, as a whole, the large scale demonstrations at farmers' field under precision farming techniques were successful in building the confidence among the farmers about the techniques of modern agriculture. They are convinced that by adopting the practices such as soil test based input application can save the unnecessary cost on fertilizer inputs, timely management of pests as per standard package of practices can control pest and disease occurrence better in crops, intervention through amendments and foliar nutrition can fetch higher crop yields etc. There is need to upscale these for adoption by other farmers with focused attention on economics and pollution.
4. The adoption of grid based soil tests at yearly interval and application of test based nutrients were found to be tedious and time consuming. Better precision farming techniques like use of satellite data, use of tractor mounted or hand held sensors could reduce the drudgery of the work. In recent days, there are a number of innovations that are contributing greatly to the concept of precision farming. Satellites, drones and even self-driven tractors with precision seeders are changing the way farmers are producing crops.
5. Precision agriculture is not economically viable in Indian context owing to small, marginal and fragmented land holdings, which invalidate the benefits of higher crop return and savings on fertilizer inputs. Moreover, most of the precision agriculture tools and techniques are yet to be standardized for better adoptability even in developed nations with large land holdings.
6. Convergence of line departments in implementation of the technology may benefit the farming community in the long run in releasing of fertilizer subsidy as well as correction of imbalanced use of fertilizers by farmers which may lead to low productivity.
7. Multidisciplinary participation in developing and implementing recommendations is needed.