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Assessment of the Extent and Determinants of Adoption of Precision Farming Technologies

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ABSTRACT

Growing population demands more agricultural production. But, there is no scope for expanding land and increasing trend in diversion of cultivable land for non agricultural purposes. The only option remained to increase agricultural production is adoption of improved technology and efficient use of available resources. Among the technological developments, precision farming has emerged as a promising option for increasing and sustaining the agricultural productivity in the semi arid tracks. 'Precision Farming' aims at increasing productivity, decreasing production costs and minimizing the environmental impact of farming. Adoption and success of precision farming in India will depend on the fact, that whether adoption strategies are designed properly or not. In this context, the present study has been undertaken to understand the adoption and impact of precision farming on resource-poor regions and underprivileged farmers. The survey method was practiced, the sample size of 120 respondents were randomly selected to study the extent of and the determinants of adoption. Mann-Whitney U test was used to analysis the statistical analysis for find out the determinants of adoption with the comparison of non adopters. The study has identified the extent and determinants of adoption of precision farming.

Key words *Precision Farming, Adoption, Determinants, Tamil Nadu*

Scope of adoption of any technology in our country not only depends on necessity, but also depends on the scientific environment of our country. The scientific temperament helped the adoption of precision farming in India directly or indirectly. Over exploitation of land as well as excessive use of agricultural input are typical problems. Precision farming can be classified into two categories, namely 'soft' and 'hard' PF. 'Soft' PF mainly depends on visual observation of crop and soil management decision based on experience and intuition,. Whereas 'hard' PF utilized all modern technologies like GPS, RS, VRT. Land fragmentation is considered as main obstacle for large scale agricultural mechanization in India. But, these fragmented lands are cultivated in family responsibility system and all small farmers followed consciously 'soft' PA technology for centuries.

Application of advanced, environment friendly technology, which can manage and allocate efficiently all resources for sustainable development of agriculture, is need of the hour. Precision farming is such a new emerging, highly promising technology, spreading rapidly in the developed countries. Precision farming is a scientific endeavour to improve the agricultural management by application of information technology (IT) and satellite based technology (e.g. global positioning system, remote sensing etc.) to identify, analyze, manage the spatial and temporal variability of agronomic parameters (e.g. soil, disease, nutrient, water etc.) within field by timely application of required amount of input to optimize profitability, sustainability with a minimized impact on environment. 'Integrating farmer knowledge, precision agriculture tools, and crop simulation modelling to evaluate management options. The present study was conducted in Dharmapuri district of TN to find out the extent and determinants of adoption. The study also find out the scope and future strategies for proper adoption of precision farming in Indian agriculture.

MATERIALS AND METHODS

The study was conducted in Dharmapuri district and data on precision and non-precision farming were collected through the interview schedule during the year 2012. The respondents were selected randomly from the five identified blocks in such a way that there were 60 adopters and 60 non adopters of precision farming, making the total sample of 120 respondents. Analysis the socio-personal variables related to the adoption of precision farming technology, extent of adoption, and the determinants of adoption by using statistical tools of frequency, percentage and Mann Whitney U test. The results discussed and the conclusion made.

RESULTS AND DISCUSSION

Socio economic variables for adoption of Precision farming

The sample farmers were classified into precision farmers and conventional farmers based on the adoption of technology as discussed in the methodology chapter.

The adoption of PF technologies mainly significant in the variables of family type, caste, education, occupation, land holding, social participation, institutional orientation, risk orientation, extension orientation, economic motivation, scientific orientation, information seeking behaviour and training undergone, are the categorical variable. So, The frequency, percentage, mann-Whitney U test were the best method for analysis the variables.

Table 1. Age distribution of the sample respondents

Age (Years)	Frequency and percentage	
	Precision farmer	Conventional farmer
< 35	18 (30)	6 (10)
36 – 55	33 (55)	38 (66.6)
> 55	9 (15)	16 (24.4)
Total	**60 (100)**	**60 (100)**
Mean rank	**56.88**	**64.13**
Mann-Whitney U test	**1582.50**	
Wilcoxon W	**3412.50**	
Z value	**-1.144**	
Probability 2 (tail)	**o.253**	

Note: Percentage were in parenthesis

In Table 1, It was observed that among the precision farming respondents, age was not a significant variable on the levels of adoption of precision farming technologies. Hence in Mann-Whitney U test, the two tail probability value was 0.253, It was more than the 5 per cent level of significance.

Table 2. Education wise distribution of the sample respondents

Education (Years)	Frequency and percentage	
	Precision farmer	Conventional farmer
Illiterate	1(1.7)	4(6.7)
Primary level	8(13.3)	23(38.3)
Up to tenth	12(20)	26(43.3)
Up to +2	35(58.3)	6(10)
Above +2	4(6.7)	1(1.7)
Total	**60 (100)**	**60 (100)**
Mean	**77.23**	**43.77**
Mann-Whitney U test	**796.00**	
Wilcoxon W	**2626.00**	
Z value	**-5.526**	
Probability 2 (tail)	**0.00****	

Note: Percentage were in parenthesis

** Highly significant at 1 per cent level.

In Table.6.2, It was observed that among the precision farming respondents, Education was a significant variable on the levels of adoption of improved precision farming technologies. Hence the same was assessed and presented in Mann-Whitney U test, the two tail probability value was 0.00, it was less than the 1 per cent level of significance so, education was a highly significant determinant of adoption of precision farming technologies.

Table 3. Caste wise distribution of the sample respondents

Caste	Frequency (f) and Percentage	
	Precision farmer	Conventional farmer
General	6(10.00)	10(16.7)
BC	33(55.00)	28(26.7)
MBC	18(30.00)	34(56.7)
SC	3(5.00)	8(13.33)
Total	**60(100)**	**60(100)**

Note: Percentage were in parenthesis

In Table. 6.3. It was observed that among the precision farming respondents, 55 per cent of the farmers were in Back ward class. In the case of non precision farmers only 26 per cent farmers were in backward class. Caste has a significant variable on the levels of adoption of improved technologies.

Table 4. Land holding wise analysis of the sample respondents

Land holding	Frequency (f) and percentage	
	Precision farmer	Conventional farmer
Marginal (0-1 ha)	0(0)	35(58.4)
Small (1-2 ha)	11(18.4)	10(16.7)
Medium (2-3 ha)	24(40)	9(15)
Big (Above 3 ha)	21(35)	6(10)
Large (Above 5 ha)	4(6.6)	0(0)
Total	**60(100)**	**60(100)**
Mean	**77.78**	**43.23**
Mann-Whitney U test	**763.500**	
Wilcoxon W	**2593.00**	
Z value	**-5.45**	
Probability 2 (tail)	**0.00****	

Note: Percentage were in parenthesis

** Highly significant at 1 per cent level.

In Table 4, It was observed that among the precision farming respondents, land holding was a significant variable on the levels of adoption of precision farming technologies. Hence the same was assessed and presented in Mann-Whitney U test the two tail probability value was 0.00, it was less than the 1 percent level of significance so, land holding was a highly significant determinant of adoption of precision farming technologies.

Table 5. Occupation wise distribution of the sample respondents

Occupation	Frequency (f) and Percentage	
	Precision farmer	Conventional farmer
Only Farming	45(75)	30(50)
Farming + Private	11(18.7)	15(25)
Farming + Govt	4(6.3)	15(25)
Total	**60(100)**	**60(100)**

Note: Percentage were in parenthesis

Occupation has a significant variable on the levels of adoption of improved technologies and hence the same was assessed and presented in Table 5. It was observed that among the precision farming respondents, 75 per cent of the farmers were doing only farming activity. In the case of conventional farmers only 50 per cent farmers were doing only farming activity.

Table 6. Family type wise distribution of the sample respondents

Family type	Frequency (f) and Percentage	
	Precision farmer	Conventional farmer
Up to 4 members	43(71.7)	30(50)
5-6 members	15(25.0)	18(30.0)
Above 6	2(3.3)	12(20)
Total	**60(100)**	**60(100)**

Note: Percentage were in parenthesis

Family type has a significant variable on the levels of adoption of Precision farming technologies and hence the same was assessed and presented in Table 6. It was observed that among the precision farming respondents, 71.7 per cent of the farmers were in nuclear family in the case of conventional farmers also only 50 per cent of the farmers were in nuclear family.

Table 7. Social Participation of the sample respondents

Social participation	Frequency (f) and percentage	
	Precision farmer	Conventional farmer
Member in farmers organization	52(87.8)	26(44.3)
Office bearer	4(6.4)	6(10)
Non Member in farmer organization	4(6.4)	28(46.7)
Total	**60(100)**	**60(100)**
Mean rank	**90.50**	**30.50**
Mann-Whitney U test	**0.00**	
Wilcoxon W	**1830.00**	
Z value	**-10.90**	
Probability 2 (tail)	**0.00****	

Note: Percentage were in parenthesis

** Highly significant at 1 per cent level.

In Table 7, It was observed that among the precision farming respondents, social participation was a significant variable on the levels of adoption of improved precision farming technologies and hence the same was assessed and presented in Mann-Whitney U test the two tail probability value was 0.00, it was less than the 1 percent level of significance so, social participation was a highly significant determinant of adoption of precision farming technologies.

Table 8. Information seeking behaviour of the sample respondents

Information seeking behaviour	Frequency (f) and percentage	
	Precision farmer	Conventional farmer
More Frequently	11(33.3)	5(8.3)
Frequently	29(48.3)	20(33.3)
Less frequently	20(33.3)	29(48.3)
Occasionally	0(0)	4(6.7)
Rarely	0(0)	2(3.3)
Total	**60(100)**	**60(100)**
Mean Rank	**83.05**	**37.95**
Mann-Whitney U test	**447.00**	
Wilcoxon W	**2277.00**	
Z value	**-7.377**	
Probability 2 (tail)	**0.00****	

Note: Percentage is in parenthesis

** Highly significant at 1 per cent level.

In Table 8, It was observed that among the precision farming respondents, Information seeking behaviour was a significant variable on the levels of adoption of improved precision farming technologies. Hence the same was assessed and presented in Mann-Whitney U test the two tail probability value was 0.00, it was less than the 1 percent level of significance so, information seeking behaviour was a highly significant determinant of adoption of precision farming technologies.

Table 9. Extension orientation wise distribution of the sample respondents

Extension orientation	Frequency (f) and percentage	
	Precision farmer	Conventional farmer
Frequently	10(16.3)	0(0)
Less frequently	25(41.7)	22(37.6)
Rarely	25(41.7)	38(63.3)
Total	**60(100)**	**60(100)**
Mean rank		
Mann-Whitney U test	**110.00**	
Wilcoxon W	**1940.00**	
Z value	**-9.19**	
Probability 2 (tail)	**0.00****	

Note: Percentage were in parenthesis

** Highly significant at 1 per cent level.

In Table 9, It was observed that among the precision farming respondents, Extension orientation had a significant variable on the levels of adoption of improved precision farming technologies and hence the same was assessed and presented in Mann-Whitney U test the two tail probability value was 0.00, it was less than the 1 percent level of significance so, extension orientation was a highly significant determinant of adoption of precision farming technologies

Table 10. Institutional engagement wise distribution of the sample respondents

Institutional engagement	Frequency (f) and percentage	
	Precision farmer	Conventional farmer
Frequently	8(13.3)	0(0.0)
Less frequently	26(43.3)	22(36.7)
Rarely	26(43.3)	38(63.3)
Total	**60(100)**	**60(100)**
Mean rank	**89.03**	**31.97**
Mann-Whitney U test	**88.00**	
Wilcoxon W	**1918.00**	
Z value	**-9.12**	
Probability 2 (tail)	**0.00****	

Note: Percentage were in parenthesis

** Highly significant at 1 per cent level.

In Table 10, It was observed that among the precision farming respondents, Institutional engagement had a significant variable on the levels of adoption of improved precision farming technologies and hence the same was assessed and presented in Mann-Whitney U test the two tail probability value was 0.00, it was less than the 1 percent level of significance so, Institutional engagement was a good determinants of adoption of precision farming technologies.

Table 11. Economic motivation wise distribution of the sample respondents

Economic motivation	Frequency (f) and percentage	
	Precision farmer	Conventional farmer
Very high	4(6.7)	1(1.7)
High	31(51.7)	34(56.7)
Medium	24(40)	24(40.0)
low	1(1.7)	1(1.7)
Total	**60(100)**	**60(100)**
Mean rank	**84.34**	**36.66**
Mann-Whitney U test	**369.50**	
Wilcoxon W	**2199.50**	
Z value	**-7.949**	
Probability 2 (tail)	**0.00**	

Note: Percentage were in parenthesis
** Highly significant at 1 per cent level.

In Table 11, It was observed that among the precision farming respondents, Economic motivation had a significant variable on the levels of adoption of improved precision farming technologies and hence the same was assessed and presented in Mann-Whitney U test the two tail probability value was 0.00, it was less than the 1 percent level of significance so, economic motivation was highly significant determinant of adoption of precision farming technologies.

Table 12. Scientific orientation distribution of the sample respondents

Scientific orientation	Frequency (f) and percentage	
	Precision farmer	Conventional farmer
Very high	29(48.3)	14(23.3)
High	24(40.0)	26(43.3)
Medium	7(11.7)	14(23.3)
Low	0(0)	4(6.7)
Very low	0(0)	2(3.3)
Total	**60(100)**	**60(100)**
Mean rank	**82.50**	**38.50**
Mann-Whitney U test	**480.00**	
Wilcoxon W	**2310.00**	
Z value	**-9.121**	
Probability 2 (tail)	**0.00**	

Note: Percentage were in parenthesis
** Highly significant at 1 per cent level.

In Table 12, It was observed that among the precision farming respondents, Scientific orientation had a significant variable on the levels of adoption of improved precision farming technologies and hence the same was assessed and presented in Mann-Whitney U test the two tail probability value was 0.00, it was less than the 1 percent level of significance so, Scientific orientation was highly significant determinant of adoption of precision farming technologies.

Table 13. Risk orientation of the sample respondents

Risk orientation	Frequency (f) and percentage	
	Precision farmer	Conventional farmer
Very high	0(0)	0(0)
High	32(53.3)	11(18.3)
Medium	28(46.7)	49(81.7)
low	0(0)	0(0)
Very low	0(0)	0(0)
Total	**60(100)**	**60(100)**
Mean rank	**87.57**	**33.43**
Mann-Whitney U test	**176.00**	
Wilcoxon W	**2006.00**	
Z value	**-9.12**	
Probability 2 (tail)	**0.00**	

Note: Percentage were in parenthesis
** Highly significant at 1 per cent level

In Table 13, It was observed that among the precision farming respondents, Risk orientation had a significant variable on the levels of adoption of improved precision farming technologies and hence the same was assessed and presented in Mann-Whitney U test the two tail probability value was 0.00, it was less than the 1 percent level of significance so, risk orientation was a highly significant determinant of adoption of precision farming technologies.

Table 14. Trainings undergone of the sample respondents

Trainings undergone	Frequency (f) and percentage	
	Precision farmers	conventional farmers
Frequently	6(10.00)	2(3.33)
Occasionally	40(66.67)	0(0.00)
Rarely	14(23.33)	0(0.00)
Not attended	0(0.00)	58(96.67)
Total	**60(100)**	**60(100)**
Mean rank	**90.50**	**5430.00**
Mann-Whitney U test	**0.00**	
Wilcoxon W	**1830.00**	
Z value	**-9.587**	
Probability 2 (tail)	**0.00**	

Note: Percentage were in parenthesis

** Highly significant at 1 per cent level.

In Table 14, It was observed that among the precision farming respondents, Training undergone had a significant variable on the levels of adoption of improved precision farming technologies and hence the same was assessed and presented in Mann-Whitney U test the two tail probability value was 0.00, it was less than the 1 percent level of significance so, training undergone was a good determinants of adoption of precision farming technologies.

Extent of Precision Farming Technology adoption

It was adopted by TNAU in the Dharmapuri district of Tamil Nadu, totally, Five package of technologies were important in the adoption of precision farming technologies in that area. They are Hi-Tech community nursery, drip and fertigation System, innovative crop geometry, chisel plough for soil management and improved varieties and hybrids.

Chisel plough for land preparation

The chisel plough technology to prepare the soil to ensures better aeration to root zone and effective drainage during rainy days. Further it helps the plants to develop root system with characteristic uniform pattern. The chisel plough needs to be operated once in two years.

Hi-Tech Community Nursery:

The seedlings are to be raised in pro trays under net houses with insect proof netting making use of (EC and pH adjusted) coco peat media treated with pseudomonas. The seedlings produced will be strikingly uniform with similar physical and physiologically 100 per cent productive plants.

Drip and Fertigation System

Drip and fertigation system ensures water saving, precise application of water soluble fertilizers to root zone and keep an ideal soil moisture regime. Fertigation ensures precise dosage at critical stages of the crop in the immediately available form. hence the crop growth was unchecked throughout the crop period. Extended harvest is possible with fertigation.

Innovative crop geometry

Row crop geometry practices useful for application of effective spray of pesticides, other intercultural operations, management of the farm for more productivity and residual toxicity is comparatively less than the conventional system.

Improved varieties and hybrids

Precision farming is a input intensive productivity oriented farming practices so the Improved varieties and hybrids are very important to enrich the PF practices.

Table. 15. Adoption of Precision Farming Technologies.

Technology	Fully Adopted	Partially Adopted	Poorly adopted
Chisel plough	24(40.0)	11(18.33)	25(41.6)
Hi-Tech Community Nursery	39(65.00)	15(25.00)	6(10.00)
Drip and Fertigation System	60(100.00)	0(0.00)	0(0.00)
Improved varieties/ hybrids	36(60.00)	11(18.33)	13(21.66)
Innovative crop geometry	32(53.3)	18(30)	10(16.7)
Average	**63.02**	**18.99**	**17.99**

The Table 15, indicated that, the adoption of PF technologies mainly concerned 1. The perceived attributes of PF (Initial cost, Compatibility, Profitability Complexity, Observability, Trial ability). 2. The farmers socio personal factors, 3. The change agents promotional capacity. In the all eight crops (Turmeric, Tapioca, Sugarcane, cotton, Banana, Tomato, Brinjal, Chillies) of precision farming, the package of precision farming technologies were adopted by farmers. Some of the technologies were reinnovated. In overall analysis of technology adoption of sample farmers adoption level at the beginning of the three years was high; but, after the extend of land to larger area; the less promotional effort of technology adoption level reduced the package of technologies.

In Chisel plough technology for soil preparation, 40 percentage of farmers were followed effectively, 18.33 per cent of farmers were practiced partially and 41.6 per cent of farmers were poorly adopted. In usage of Hi-Tech Community Nursery 65 per cent of vegetable grower were practiced effectively, 25 per cent of farmers were practiced partially and 10 per cent of farmers were poorly followed for usage of Hi-Tech Community Nursery. All farmers were adopted drip irrigation system. The main factor behind the adoption was the government subsidy. The 60 per cent of farmers were fully adopted the Improved varieties or hybrids, 18.33 per cent farmers were partially adopted and 21.66 percentage of farmers were poorly adopted. In case of innovative crop geometry 53.3 percentage of farmers were adopted the practices potentially, 30 percentage were adopted partially and only 16.7 percentage were poorly adopted. Based on the five package of PF technology adoption were association with other technology. In addition to all, the percentage calculation indicate that among the adopter category of precision farmers 63.02 percentage of farmers were actively adopted all package of technology. 18.99 percentage of farmers were partially adopted and 17.99 percentage of farmers were poorly adopted the PF technologies.

The Subsidy effect, extension effort by change agents, the education level of the respondents and the training efforts were the main other determinants supported to adopt the precision farming technology.

This study, to assess the adoption of precision farming technology on socioeconomic variables of family type, caste, education, occupation, land holding, social participation, institutional orientation, risk orientation, extension orientation, economic motivation, scientific orientation, information seeking behaviour and training undergone, involvement showed that the main determinant of adopt the PF technology. The Subsidy effect, extension effort by change agents and the training efforts were the main other determinants associated in adopt the precision farming technology. Because in the Tamil Nadu precision farming project initial period (2003-2007), the adoption level and impact was very good. The intensified extension research and extension effort were played a key role to promote the technology in large farmers with high financial motivation and training effort. But, after the initial years the TNAD, TNHD were not played that much intensified effort and they given only subsidy to promote the technology. So due to the subsidy effort the extent of adoption the drip irrigation technology only 100 percent adoption occurred.

The study of Palanisamy (2011) indicating that the subsidy effort of TN – IAMWARM project benefited the majority of the precision farming beneficiaries. Earlier precision farming studies focussed only the TNPFP whole adoption of PF in Dharmapuri district. the study of R.Maheswari(2007) indicating that the adoption of precision farming technologies in Brinjal and tomato, other vegetables were good for PF. Other crops were not that much effective as compare to the conventional farming and in case of input usage efficiency and environmental friendly factor it is recommended but in Indian farmers condition the prime priority to focus the food security and economic benefit only.

CONCLUSION

Precision farming has created scope of transforming the traditional agriculture, through the way of proper resource utilization and management, to an environmental friendly sustainable agriculture. socioeconomic variables of family type, caste, education, occupation, land holding, social participation, institutional orientation, risk orientation, extension orientation, economic motivation, scientific orientation, information seeking behaviour and training undergone, involvement showed that the main determinants of adoption of the PF technology. The Subsidy effect, extension effort by change agents, and the training efforts were the main other determinants associated in adopt the precision farming technology. The intensified extension research and extension effort were played a key role to promote the technology in farmers with high financial motivation and training effort.

Due to the subsidy effort, the extent of adoption the drip irrigation technology only 100 per cent adoption occurred. In addition to all, the percentage calculation indicate that among the adopter category of precision farmers 63.02 percentage of farmers were actively adopted all package of technology. 18.99 percentage of farmers were partially adopted and 17.99 percentage of farmers were poorly adopted the PF technologies. Future strategy of innovative extension strategy to cover 'Integrating farmer knowledge and information data base management is important factor to for adoption of PF in India.

LITERATURE CITED

R. Maheswari, K.R. Ashok 2007. Precision Farming Technology, Adoption Decisions and Productivity of Vegetables in Resource-Poor Environments Unpub. M.Sc. (Ag.) Thesis, AC&RI, TNAU, Coimbatore.

http://www.tn.gov.in

www.iamwarm.gov.in.

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