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Analysis of the Profile Characteristics and Attitude of the Farmers, Extent of Adoption and Constraints in Taking up Precision Farming in Kerala

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Abstract: The growing food demand due to ever-rising human population but limited land resources is forcing Indian farmers to adopt resource intensive and unsustainable practices that increase both economic and environmental costs. Precision farming is information and technology based farm management system to identify, analyse and manage variability within fields by doing all practices of crop production. With an illustration from 60 precision farmers and 30 conventional farmers from Palakkad district of Kerala, the paper attempts to analyse the profile characteristics of the farmers, attitude and extent of adoption, and constraints in taking up precision farming.

Keywords: Precision farming, Fertigation, attitude, Adoption, Palakkad District, Kerala.

CONCEPTS OF PRECISION FARMING:

The concept of Precision Farming (PF) according to Fairchild (1994) is based on the fact that variability of soil fertility, soil depth, micro-relief, microclimate, weed species, etc. are natural and site-dependent, and therefore have a direct bearing on crop production. Gerhards et al. (1996) reported that crop production is achieved from

"prescribed" inputs made on an "as needed basis" and calls upon the support of information and engineering technologies such as micro-computers, Geographical Information Systems (GIS), Global Positioning System (GPS) and automatic control of farm machinery. Instead of managing fields with average requirements or with general types of recommendation, fields can now be managed by variable rates of inputs that are specific to the site conditions. By this method, crop yield can be better controlled and low-yielding areas can be better managed – resulting in increased productivity. It will also result in a judicious use and economy of inputs as well as being environment friendly. Extra inputs of fertilizers or biocides in non-desired areas will then be avoided thereby minimizing risks of pollution. Other names used in Precision Agriculture are PF (Prescriptive Farming), Variable Rate Farming, Site-Specific Management, Soil Specific Crop Management, Farming by Computer, Farming by Satellite, Computer-assisted Agriculture, Automated Agriculture, Farming by Foot, Cyber Farm, etc.

Precision Farming in Kerala

Perumatty in Palakkad district of Kerala started taking up PF replicating the model followed in Tamil Nadu for the last 5-6 years. A report of the daily, *The Hindu* on 17th June 2011 reported that nearly 1,000 farmers have registered with Vegetable and Fruits Promotion Council, Keralam, and other agencies in Chittur taluk to take up vegetable cultivation starting in July-August 2011. Some farmers in Kollam and Alappuzha districts have also taken up PF. Of the 1,000 farmers who have taken up PF in the State, 700 were in Palakkad district. About 550 new farmers took to PF in the district in 2012. Most have opted to farm vegetables, due to their high productivity and good profit. Nearly 800 farmers have registered with the Vegetable and Fruit Promotion Council Keralam (VFPCK) and other agencies in Chittur to take up vegetable cultivation. In Chittur, 10 Kudumbashree units have adopted it.

More than 50 farmers of Perumatty Precision Farmers Cluster have taken up PF under the guidance of the Perumatty Service Co-operative Bank on one hectare demonstration plot at Agro processing

campus, Kambalathara growing crops like Chilli-F1 hybrid MHCP317, Brinjal-F1 hybrid MHB9, Banana-G9, etc. The Perumatty and the Pattancherry grama panchayats have submitted precision-farming projects estimated at Rs.1.75 crore under the Rashtriya Krishi Vikas Yojana. An Agro Service Centre has been set up with the assistance of the Rashtriya Krishi Vikas Yojana (RKVY) which has provided a sum of one crore in May 2012. Precision farmers got an annual profit between Rs.75,000 and Rs.2.5 lakh from an acre. G-9 plantain, chilli, tomato, cucumber, etc. are being cultivated in large numbers by educated young farmers. Besides Palakkad, more or less kind of PF have been taken up in parts of Wayanad, Kottayam, Kollam, Pathanamthita, Idukki and Alleppey where fertigation are taken up in small and large scales which is a main component of PF. Palakkad farmers felt the lack of full time technical support. Drainage in rainy season in open fields, Fertigation schedule formulation which is not in accordance with soil and water test results, unavailability of F1 hybrid in Kerala and lack of well-established marketing network are some of the current problems faced by them.

RESEARCH APPROACH AND SETTING

Recognizing the importance of Hi-tech agriculture, governments at both central and state levels have chalked out several schemes to promote PF and to make agriculture a business proposition. The government of Kerala has also launched a massive project to promote PF during 2011-12 and there is an urgent need to collect field evidences to serve as a non-failing measure for improved future performances of these schemes. It is with this broad objective, that the present research was designed.

Specific Objectives:

1. To study the profile and socio-economic conditions of the respondents.
2. To assess the use and extent of adoption of PF in Kerala.
3. To study the attitude of farmers towards PF.
4. To identify the constraints and formulate strategies for scaling up PF in Kerala.

Scope and importance of the study:

The study focuses on the extent of farmers' adoption of PF technologies. It also gives equal importance to the constraints and problems faced by farmers. This study will be much useful to researchers, extension workers and policy makers as to what extent the technologies were adopted by farmers to take up corrective measures. Comparative advantage of PF over conventional farmers, attitude, adoption pattern, and factors affecting adoption of the PF technologies will also be exploited. It will help them to get a clue for greater diffusion and adoption of PF practices on a larger scale. The results of the study pertaining to the suggestions would help to take appropriate measures to scale up PF on sustainable basis in Kerala.

Research Design

In the present study, the main aim is to analyse the adoption and impact of PF; for that *Ex post facto research design* was employed. In *Ex post facto research,* the investigator draws the inference regarding the relationship between variables on the basis of independent variable whose manifestation has already occurred. In this design, the investigator has no scope to manipulate the independent variables, as they had already occurred. Inferences on the relationships between independent and dependent variables are drawn on the basis of effects already manifested.

Method of data collection

Taking into consideration the scope and objectives of the study, a draft interview schedule was prepared after perusal of available literature and through consultation with experts in the field of extension education and other related fields. After incorporating their suggestions, a well-structured interview schedule was finalized in English. Pre-testing was done to probe into the relevancy of the schedule to suit the area under study in the non-sampling area. Based on the results of pre-testing, suitable modifications were made and a final interview schedule was prepared. The respondents were personally contacted for collection

of data. The data so collected were subjected to statistical analysis and interpretation was made for drawing meaningful conclusions**.**

Selection of the respondents:

The study was conducted with two major groups of respondents – PF adopters and PF Non adopters. Respondents were selected by using simple random sampling technique. It accomplished a total of sixty PF adopters and thirty conventional farmers.

Selection, Operationalisation and measurement of variables

Based on the objectives, review of literature, discussion with experts and observation made by the researcher, a list of personal and socio-psychological characteristics were identified along with their operational definitions and sent to 30 judges for eliciting their relevancy on a three point continuum ranging from most relevant to least relevant. 12 independent variables were selected. Level of adoption of PF and attitude of the farmers were the dependent variables. The scores were assigned as follows:

Response	**Score**
Most relevant	3
Relevant	2
Least relevant	1

The total score obtained for each variable is worked out. The variables having a score value of 75 per cent and above were selected. List of variables along with measurements are elucidated in the tables in the later pages.

Tools for statistical analysis

The data collected from the respondents were scored, tabulated and analysed using suitable statistical methods. Keeping in view the objectives of the study and amenability, the data were subjected to different statistical tools. These tests include mean, standard deviation,

and percentage which were used in comparison to different categories and frequencies. Correlation coefficient was also used in analysing the data.

Hypothesis testing

Correlation analysis was done to test the null hypothesis to find out whether the dependent variables were significantly related or not.

Description of the study area: Palakkad District

Palakkad is situated in the north eastern corner of Kerala. It is located between latitudes *10°46'30"N* and *10.775°N* and longitudes *76°39'04"E* and *76.651°E*. The city of Palakkad is the district headquarters. Palakkad is bordered on the northwest by Malappuram District, on the southwest by Thrissur District and on the east by Coimbatore district of Tamil Nadu. The district is 13.62% urbanised. It is predominantly a rural district. Palakkad is the gateway to Kerala due to the presence of the Palakkad Gap in the Western Ghats. The total area of the district is 4480 km² which is 11.5% of the state's area. Out of the total area of 4480 km², about 1360 km² of land is covered by forests. Most parts of the district fall in the midland region (elevation 75–250 m), except the Nelliampathy-Parambikulam area in the Chittur taluk in the south and Attappadi-Malampuzha area in the north, which are hilly and fall in the highland region (elevation >250 m).

The district is nicknamed "the granary of Kerala" as well as "rice bowl of Kerala". The soil type ranges from black to mixed loam. The climate is hot and humid for most part of the year. Palakkad is one of the hottest places in Kerala. There is sufficient rainfall. The district is blessed with many small and medium rivers which are tributaries of the Bharathapuzha. As the area is drought prone with “Savanna type climate” (Tropical savanna climate), it has become essential to switch over to cultivation of drought tolerant perennial fruit and vegetable crops. The summers are generally warm and dry. Monsoon season (experiences a long monsoon) brings substantial amount of rainfall to this region and winters are generally pleasant and comfortable.

Fig 1: Map of Palakkad district

Fig. 2: Taluks of Palakkad district

The district is divided into five taluks – Alathur,Chittur,Mannarkkad, Ottappalam and Palakkad. There are 13 development blocks and 90 Grama panchayats in the district.

Findings and Results:

Profile characteristics of the respondents

A clear understanding of the socio-economic and psychological characteristics of the respondents would enable the investigator to interpret the data. For this purpose fourteen variables were selected and included in the study.

(i) *Age*

Table 1: Distribution of respondents according to their age

Sl. No.	Category	Precision farmers n=60		Conventional farmers n =30	
		Frequency	%	Frequency	%
1	Young	6	10	0	0
2	Middle	6	10	19	63.33
3	Old	48	80	11	36.67

From the table it is observed that majority of the precision farmers (80 %) belong to old age category and majority of conventional farmers belong to middle age category (63.33 %). Only 10 per cent are young precision farmers.PF is a new technique of farming in the study area. So, it is natural to find middle and old age group of farmers who have more experience in following PF farming. A similar result was reported by Jahagirdar and Sundarasamy (2002), Fayas (2003) and Jayashree (2004).

(ii) *Education*

Table 2: Distribution of respondents according to their education

Sl no	Category	Precision farmers n =60		Conventional farmers n =30	
		Frequency	Percentage	Frequency	Percentage
1	Illiterate	0	0	0	0
2	Primary	3	5	5	16.67

3	High School	33	55	15	50
4	Higher Sec.	14	23.33	8	26.67
5	College	10	16.67	2	6.66

Table 2 reveals that all the farmers were literate. More than 50% of both the categories of farmers have attended High school.The higher literacy rate in the state is reflected in the results of the study. A similar result was reported by Ramachandran (1997), Sriram (1997), Sherief (1998) and Palanisamy (2011).

(iii)*Farming Experience*

Table 3: Distribution of respondents according to their farming experience

Sl. No.	Category	Precision farmers n=60		Conventional farmers n=30	
		Frequency	Percentage	Frequency	Percentage
1	Up to 5 years	0	0	1	3.33
2	6-10 years	0	0	1	3.33
3	11-25 years	28	46.67	5	16.67
4	Above 25 years	32	53.33	23	76.67

From table 3, it is observed that majority of the precision farmers (53.33%) and conventional farmers (76.67%) had more than 25 years of farming experience. Farmers with less than 10 years of experience were negligible because of the reason that farming has been the primary occupation in the study area. A similar result was reported by Santhasheela (1999) and Kamalakkannan (2003).

(iv) *Precision Farming Experience*

Table 4: Distribution of respondents according to their PF experience

Sl. No.	Category	Precision farmers n = 60		Conventional farmers n = 30
		Frequency	Percentage	Not applicable
1	Upto 1 year	6	10	NA
2	Upto3 years	54	90	NA
3	Upto and above 5 years	0	0	NA

PF is a new technique employed in the study area. It is clear from the table that majority of the farmers (90 %) have upto 3 years experience followed by 10% having upto one year experience. No

farmers had upto 5 years of experience. The study derived support from the finding of Palanisamy (2011) and Anirban (2012).

(v) *Information seeking behaviour*

Table 5: Distribution of respondents according to their information seeking behaviour

Sl. No.	Category	Precision farmers n=60			Conventional farmers n=30		
		Score range	Frequency	Percentage	Score range	Frequency	Percentage
1	Low	<29.59	8	13.33	<13.90	5	16.67
2	Medium	29.59-36.30	44	73.34	13.90-23.89	19	63.33
3	High	>36.30	8	13.34	>23.89	6	20
		Mean: 32.95	SD: 3.35		Mean: 18.9	SD:4.99	

From table 5, it is discerned that majority of the respondents belong to medium category with respect to information seeking behaviour. But precision farmers had a higher percentage of 73.34% as compared to 63.33% for conventional farmers. It is because precision farmers had regular access to newspapers, journals, television and contacts with fellow precision farmers. This finding was in agreement with that of Kumar (1994) and Sriram (1997) but in contradiction with Palanisamy (2011) where the respondents had higher level of information seeking behaviour.

(vi) *Training Attended*

Table 6: Distribution of respondents according to training attended

Sl. No.	Category	Precision farmers n=60		Conventional farmers n=30	
		Frequency	Percentage	Frequency	Percentage
1	No training	0	0	17	56.67
2	1-5 trainings	2	3.33	12	40
3	6-10 trainings	23	38.33	1	3.33
4	More than 10	35	58.34	0	0

From the perusal of table 6, it is observed that 58.34% of precision farmers had attended more than 10 trainings and 38.33% had attended from6 to 10. It is in contrast in case of conventional farmers. 56.67% of conventional farmers had no training followed by 40% who had attended one to five trainings. A similar trend was reported by Parvathy (2000) in case of conventional farmers where the farmers had medium to level of training. But it is in contrast for precision farmers. It was in line with Palanisamy (2011) and Anirban(2012) where precision farmers were more training orient.

(vii) *Extension Orientation*

Table 7: Distribution of respondents according to their extension orientation

Sl. No.	Category	Precision farmers n=60			Conventional farmers n=30		
		Score range	Frequency	Percentage	Score range	Frequency	Percentage
1	Low	<14.04	5	8.33	<11.58	5	16.67
2	Medium	14.09-17.38	46	76.67	11.58-13.81	17	53.33
3	High	>17.38	9	15	>13.81	9	30

Mean: 15.71 SD: 1.66 Mean: 12.7 SD: 1.11

The data in table 7 shows that majority of respondents had medium extension orientation followed by high and low levels of extension orientation in both the categories of respondents. Precision farmers had 76.67% medium level of orientation as compared to 53.33% for conventional farmers. It was because of the fact that precision farmers had more contacts with the agricultural officers of the concerned panchayats. They used to attend regular training classes, demonstrations, farm visits, etc. This finding was in line with Manjusha (1999) but in contrast with Suthan (2003).

(viii) *Economic Motivation*

Table 8: Distribution of respondents according to their economic motivation

Sl. No.	Category	Precision farmers n=60			Conventional farmers n=30		
		Score range	Frequency	Percentage	Score range	Frequency	Percentage
1	Low	<19.51	0	0	<16.63	1	3.33
2	Medium	19.51 - 23.88	39	65	16.63-20.89	27	90
3	High	>23.88	21	35	>20.89	2	6.67
		Mean: 21.7 SD: 2.1			Mean: 18.76 SD: 2.12		

From the table, it is inferred that a higher percentage of the respondents had medium level of economic motivation (65%) and 35% were highly economically motivated. So, their main motive was to harvest good quality produce from their available land utilizing PF practices. Also 90% of the conventional farmers had medium level of economic motivation. A similar trend was also emphasized by Krishnakumar (1996), Sriram (1997), Fayas (2003) and Thangaraja (2008).

(ix) *Risk Orientation*

Table 9: Distribution of respondents according to their risk orientation

Sl. No.	Category	Precision farmers n=60			Conventional farmers n=30		
		Score range	Frequency	Percentage	Score range	Frequency	Percentage
1	Low	<20.19	0	0	<17.28	0	0
2	Medium	20.19-27.20	23	38.33	17.28-20.84	29	96.67
3	High	>27.20	37	61.67	>20.84	1	3.33
		Mean: 23.7 SD: 3.50			Mean: 19.06 SD: 1.77		

From the table, it is clear that the precision farmers are highly risk oriented. 61.67% fell in the high level followed by 38.33% in medium level. But 96.67% of the conventional farmers had medium level of risk orientation. Risk taking behaviour was essential for the adoption of organic farming practices in vegetable cultivation. Farmers had to spend more on inputs for getting more output and take certain amount of risks in cultivating vegetables. All these factors contributed to medium level of risk orientation. A similar result was reported by Krishnakumar (1996), Santhasheela (1999), Fayas (2003) and Thangaraja (2008).

(x) *Scientific Orientation*

Table 10: Distribution of respondents according to their scientific orientation

Sl. No.	Category	Precision farmers n=60			Conventional farmers n=30		
		Score range	Frequency	Percentage	Score range	Frequency	Percentage
1	Low	<22.77	0	0	<16.96	0	0
2	Medium	22.77-28.55	10	16.67	16.96-21.96	27	90
3	High	>28.55	50	83.33	>21.96	3	10
		Mean: 25.66 SD: 2.89			Mean: 19.46 SD: 2.50		

The table shows clearly that the precision farmers were more scientifically oriented; 83.33% of them had high level of scientific orientation followed by medium level. But in case of conventional farmers, 90% of them had medium level of scientific orientation. Over all, we can say that the respondents were medium to highly scientific in their approach to take up PF practices. The reason for high to medium level of scientific orientation might be due to their increased research agency contact, better trainings undergone and also their faith on the PF technologies compared to traditional or normal method. This helped the respondents to gain adequate knowledge on PF technologies. This finding is in line with the findings of Sangeetha (2009) and Palanisamy (2011).

(xi) *Market Perception*

Table 11: Distribution of respondents according to their market perception

Sl. No.	Category	Precision farmers n=60			Conventional farmers n=30		
		Score range	Frequency	Percentage	Score range	Frequency	Percentage
1	Low	<4.22	16	26.67	<4.07	1	3.33
2	Medium	4.22-5.37	39	65	4.07-5.18	29	96.67
3	High	>5.37	5	8.33	>5.18	0	0
		Mean: 4.8 SD: 0.57			Mean: 4.63 SD: 0.55		

From the perusal of table 11, it is observed that 96.67% of conventional farmers had better market perception than precision farmers (65%). But majority of the respondents had medium level of market perception followed by low and high levels. Precision farmers, being practitioners of a new technique, might not be aware of the opportunities and the vast market and the prices the produce can fetch in the market. In case of conventional farmers, they are more content with the production and the price they get, and were not very highly market oriented. This was in contrast with the findings of Suthan (2003) and Fayas (2003).

(xii) *Innovativeness*

Table 12: Distribution of respondents according to their innovativeness

Sl. No.	Category	Precision farmers n=60			Conventional farmers n=30		
		Score range	Frequency	Percentage	Score range	Frequency	Percentage
1	Low	<2.76	1	1.66	<1.16	10	33.33
2	Medium	2.76-3.33	55	91.67	1.16-2.23	19	63.33
3	High	>3.33	4	6.67	>2.23	1	3.34
		Mean: 3.05 SD: 0.28			Mean: 1.7 SD: 0.53		

It is clear from the table that majority of the respondents had medium level of innovativeness. Precision farmers had 91.67% as compared to 63.33% for conventional farmers in innovativeness. Most of the precision farmers were influenced by the success stories of other nearby farmers. Monetary and technical assistance given by Perummaty Co-operative Society and Perumatty Agro Service Center were the main force behind the diffusion of the innovation besides mass media exposure. This finding was in line with that of Alagirisamy (1997), Marimuthu (1998) and Fayas (2003).

ATTITUDE OF RESPONDENTS TOWARDS PF PRACTICES

Farmers' attitude towards PF practices was studied by using an arbitrary scale and the findings are given in Table 13.

Table 13: Distribution of the respondents according to their attitude towards PF practices

Sl. No.	Category	Precision farmers n=60			Conventional farmers n=30		
		Score range	Frequency	Percentage	Score range	Frequency	Percentage
1	Low	<54.45	8	13.33	<43.69	3	10
2	Medium	54.45-65.04	46	76.67	43.69 - 52.04	22	73.33
3	High	>65.04	6	10	>52.04	5	16.67
		Mean: 59.75 SD: 5.29			Mean: 47.86 SD: 4.17		

Majority of the respondents had a favourable and medium attitude towards PF practices. 76.67% of precision farmers had medium attitude so as 73.33% of the conventional farmers. Even 10% of precision farmers and 16.67% conventional farmers had higher attitude towards the new techniques of farming. The awareness and profitability about PF practices might have led them to develop an interest towards precision farming practices. The results born out of the success stories of the fellow farmers and the profit made by them along with the

technical and financial assistance given by the Perumatty Service Co-operative Bank and Perumatty Agro Service Center, and the active participation of the agricultural officers along with the farmers proved the worthiness of PF practices.

The service provided by agro service center and the recommendations of the agricultural officers got translated into action in the field through the farmers. During monthly workshops and meetings, messages related to PF practices were discussed and disseminated among the farmers to create a favourable attitude. Publishing articles in newspapers and broadcasting and telecasting lessons on PF practices through all India Radio, Doordarshan and Asianet, besides training by VFPCK officials, acted as catalysts in the formation of favourable attitude towards PF practices. Precise application of inputs resulted in reducing the loss of unnecessary inputs, thereby minimizing the cost and maximizing the profits. Higher rate of production and productivity and also having lesser impact on the soil health status would have influenced the farmers' attitude favourably.

All the above factors might have made the farmers to develop a favourable attitude towards PF practices. This was in agreement with the findings of Kathiravan (1994), Velusamy (1996) and Sriram (1997). It is inferred from the findings that majority of the farmers had favourable attitude towards PF practices.

ADOPTION OF PF PRACTICES BY THE RESPONDENTS

Table 14: Distribution of respondents according to their adoption of PF practices

Sl. No.	Category	Precision farmers n=60			Conventional farmers n=30		
		Score range	Frequency	Percentage	Score range	Frequency	Percentage
1	Low	<3.58	1	1.67	<1.61	1	3.33
2	Medium	3.58-5.44	44	73.33	1.61-2.51	27	90
3	High	>5.44	15	25	>2.51	2	6.67
		Mean: 4.41	SD: 0.92		Mean: 2.06	SD: 0.44	

From the study about the attitude of the respondents, it could be observed that majority of them had medium and favourable attitude towards PF practices. 73.33% of the precision farmers and 90% of the conventional farmers had medium level of adoption. Moreover, 25% precision farmers had high level of adoption, so do 6.67% of the conventional farmers. Probably the awareness about the possibilities, profitability and positive attitude would have motivated the farmers to adopt PF practices to medium level of adoption followed by high and low levels. The positive trend towards PF practices by majority of the respondents was to be explained by the following factors.

PF was introduced for first time in Kerala in the study area. Chittur block was identified as one of the potential areas with reference to PF. Since farmers wanted to combat with the adverse climatic condition and the low precipitation, they tried the new practices which needed lower input but maximized profits. It also increased the standard of living by earning more. The finding was in agreement with the findings of Sathiyanarayanan (1991), Snehalatha (1991), Sundarambal (1994) and Sriram (1997). But it was in contrast with the studies reported by Rakesh (2010) and Palanisamy(2011) where precision farmer beneficiaries had higher level of adoption.

Practice-wise extent of adoption

The frequency distribution of respondents on practice-wise extent of adoption of PF practices is discussed below.

Table 15: Adoption of PF practices by the respondents

Sl. No.	PF practices	Precision farmers n=60			Conventional farmers n=30		
		Adopted	Partially adopted	Not adopted	Adopted	Partially adopted	Not adopted
1	Remote sensing and GIS	0	0	60	0	0	30
2	Land management-chisel ploughing	0	0	60	0	0	30
3	Community shade net cum portray nursery	11	4	45	0	0	30

4	Innovative crop geometry	0	2	58	0	0	30
5	Drip irrigation/ fertigation	60	0	0	1	1	28
6	Improved varieties/ varieties	60	0	0	29	1	0

From the table it could be seen that the adoption level of PF practice is very low. It may be because of the farmers socio-personal factors and the perceived attributes of PF (Initial cost, Compatibility, Profitability Complexity, Observability, Trial ability) or the changed promotional capacity. None of the farmers had used GIS and remote sensing facilities. Also chisel ploughing for soil preparation was not followed by a single respondent. 11 of the 60 precision farmers were fully using hi-tech community nursery and 4 of them were partially utilizing it. But overall 45 farmers did not adopt the practice. So there is poor usage of hi-tech community nursery. It was also not followed by the conventional farmers. Innovative crop geometry was not partially adopted by only 2 respondents. It showed that the respondents were following their own geometry and were not concerned about cropping geometry or were adamant to change their on hand knowledge.

All precision farmers adopted drip irrigation and fertigation system. One reason may be the government subsidy. Also one conventional farmer partially adopted drip irrigation. Other farmers also showed favourable attitude but had not adopted for the time being.

100% of precision farmers and 29 out of 30 conventional farmers fully adopted the use of hybrid and improved varieties of seeds. Perumatty Agro Service Centre and VFPCKs had an important role in it.

RELATIONSHIP BETWEEN THE CHARACTERISTICS OF THE RESPONDENTS WITH THE EXTENT OF ATTITUDE AND ADOPTION

The socio-economic and psychological characteristics of farmers played a vital role in determining their attitude and adoption of PF practices. Correlation analysis was employed to assess the

relationship of characteristics of respondents with their attitude and adoption of PF practices. The correlation coefficients were worked out and the significance was tested by comparing with the table values. The results are presented below.

(i) Relationship between the Characteristics of respondents and Attitude towards PF Practices

The success of any agricultural technology mostly depends upon the favourable attitude of the farmers. Hence the relationship between the attitude and the characteristics of farmers was studied and is presented in Table 16.

Table 16: Correlation between independent variables and attitude

Correlation between independent variables and attitude			
Sl.No.	Independent variables	Precision farmers n=60	Conventional farmers n=30
1	Age	NA	NA
2	Education	0.294497*	-0.25335
3	Farming experience	0.247246	-0.11164
4	PF experience	-0.16385	0
5	Information seeking behaviour	-0.36845	0.037392
6	Training attended	-0.23621	0.099266
7	Extension orientation	0.147136	-0.01624
8	Economic motivation	0.2075	0.477586**
9	Risk orientation	0.723111**	0.330721
10	Scientific orientation	0.71002**	0.735869**
11	Market perception	0.294072*	0.34956*
12	Innovativeness	0.197986	0.537272**

Note: * Significant at 5% level
** Significant at 1% level

For precision farmers, it could be observed from the table that eight variables namely, education, farming experience, extension orientation, economic orientation, risk orientation, scientific orientation, market

perception and innovativeness showed a positive relationship with attitude towards PF practices. But for conventional farmers, seven variables namely, information seeking behaviour, training attended, economic motivation, risk orientation, scientific orientation, market perception and innovativeness showed a positive relationship with the attitude towards PF. Education had a significant and positive relationship with precision farmers' attitude. Educated farmers had an opportunity to adopt PF practices because of greater exposure and interaction within and outside the social system which would have aided to greater adoption of PF practices. This finding was in line with that of Krishnakumar (1996), Sujatha (1996), Sriram (1997), Sudhakar (1998), Syamkumar (1999) and Majjusha (2000). But for conventional farmers, education had a negative correlation showing that education level has nothing to do with adoption of PF practices.

A significant and positive relationship existed between economic motivation and attitude for conventional farmers, but not significant for precision farmers. Conventional farmers are more highly motivated economically as compared to fellow precision farmers. Likewise, risk orientation had a highly significant relationship with the attitude of precision farmers. Risk taking ability of the farmers was high because of the profits and advantages of PF over conventional farming. It also had a positive relationship with the attitude of conventional farmers. Both the respondent types had a significant and positive relationship between scientific orientation and attitude towards PF practices. The farmers were more scientifically oriented and were interested in trying out the new technique of farming. Market perception had a significant and positive relationship with the attitude. Market perception was capable of changing the attitude towards PF practice due to the high demand for quality produce at lower prices through PF practices. This might have changed the attitude of farmers.

A positive relationship existed between innovativeness and attitude towards PF practices. Conventional farmers were not less in innovativeness. They had a significant relationship with their attitude. Farmers with more innovativeness would have been much interested to use all PF practices relatively earlier than others. So, farmers would have always been ready to accept the technologies without any delay.

This might have influenced the attitude towards PF practices. A similar finding was reported by Sajeevchandran (1989), Gangadharan (1993), Varma (1996), Sriram (1997) and Parvathy (2000).

(ii) *Relationship between the Characteristics of respondents and Adoption of PF Practices*

Relationship between the characteristics of respondents and adoption of PF practices was worked out and is furnished in Table 17.

Table 17: Correlation between independent variables and adoption

Correlation between the independent variables and adoption			
Sl. No	Independent variables	Precision farmers	conventional farmers
1	Age	NA	NA
2	Education	0.196526	0.143851
3	Farming Experience	0.016984	-0.09869
4	PF experience	0.089892	0
5	Information seeking behaviour	0.062902	-0.11979
6	Training attended	0.019492	-0.12524
7	Extension orientation	0.196526	-0.02741
8	Economic orientation	0.26134*	0.160896
9	Risk orientation	0.248014	-0.00574
10	Scientific orientation	-0.02531	0.002043
11	Market perception	0.282993*	-0.03677
12	Innovativeness	0.186832	-0.05732

Note: * Significant at 5% level
** Significant at 1% level

For precision farmers, it is noted from the table that out of 13 variables studied, eleven variables namely education, farming experience, PF experience, information seeking behaviour, training attended, extension orientation, economic motivation, risk orientation, market perception, innovativeness and attitude showed a positive relationship with adoption.

But for conventional farmers, only three variables showed positive relationship with adoption namely education, scientific orientation and attitude. Economic motivation showed a significant and positive relationship with the adoption and developed the farmers' ability to face any risks. Precision farmers had faith in precision farming practices, that it would increase their production and productivity thereby increasing their standard of living. So the farmers had started adopting PF practices. A similar result was pointed out by Syamkumar (1999).

A significant and positive relationship was seen between market perception and adoption for precision farmers. Knowledge about the market is also a pre-disposing factor for adoption. So, if a farmer has proper knowledge, he can evaluate the opportunities and the profitability of the new farming technique. The possibilities of earning more by reducing the cost of production and the ability to see beyond the domestic market made the farmers to take positive decisions and adopt PF practices.

Attitude showed a significant and positive relationship with adoption. Favourable attitude among the respondents was due to the realization of 'seeing is believing' and 'learning by doing' in PF practices. This was popularized by the agricultural officers and staffs, demonstrations, field visits and training; it boosted the morale of the farmers' attitude towards switching over from conventional and intensive agriculture to low input and higher output PF practices. But for conventional farmers, there were not any variables which showed a significant relationship with adoption.

CONSTRAINTS IN THE ADOPTION OF PF PRACTICES AS PERCEIVED BY THE RESPONDENTS AND SUGGESTIONS FOR OVERCOMING THEM

The respondents, both precision farmers and conventional farmers, were interviewed with questionnaires to state the constraints in their order of importance, which they faced in adopting PF practices. These constraints were ranked on the importance based on their perceptions.

Table 18: Constraints in the adoption of PF practices as perceived by the respondents

Sl. No.	Constraints	Ranks	
		Precision farmers	Conventional farmers
1	Rainfall and other meteorological	1	1
2	High cost inputs	1	2
3	Non availability of high value inputs	2	7
4	Complexity of tools and techniques	3	9
5	Small farms	4	5
6	Infrastructure constraints	5	14
7	Lack of local expertise	6	3
8	Market imperfection	7	10
9	Heavy fluctuation in commodity price	8	11
10	Lack of crop insurance coverage	8	12
11	Lack of price policy of PF	9	10
12	Problems of transportation	10	13
13	Non availability of skilled labours	11	7
14	High cost of labour	12	6
15	Culture, attitude and perceptions of farmers	13	4
16	Drainage	14	18
17	Attack of insect pest and diseases	15	15
18	Lack of demonstrated impacts on yields	16	17
19	Lack of awareness of agro environmental problems	17	18
20	Lack of success stories of PF adoption	17	18
21	Excessive soil erosion	18	18
22	Heterogeneity of cropping systems	18	19
23	Lack of motivation from farmers	18	17
24	Bank loans available nearby	18	16
24	Lengthy technical procedures	18	19
26	Institutional constraints	18	16
27	No Kissan Credit Card	18	16
28	Friends and neighbour discourage	18	19
29	If failed, people will criticize me	18	19
30	I may feel insulted, if crop fails	18	19

As we are concerned with the problems faced by the precision farmers, we ranked the main constraints and compared it with the constraints

that conventional farmers think was a cause for non-adoption of PF technologies. It is clear from the table that the most important constraints experienced by both categories of respondents are rainfall and other meteorological problems. It includes dry weather condition and low water level. Lack of irrigation facilities during dry season and non-availability of water was the main concern by the respondents. There should be adequate minimal quantum of water for the entire crop duration, and pumping efficiency of motor should be 12000 liter of water per hour with 1.5 kg pressure for fertigation in PF. Lack of water availability and pump efficiency was the important constraint for adopting PF. It was also supported by Maheshwari (2007). High cost of input was also the main second constraint for the precision farmers. Initial investment for Drip installation and use of water soluble fertilizers were very expensive for the farmers. Third constraint for precision farmers was non-availability of inputs. The F1 seeds also need to be imported from outside which in turn increased the input costs. It was in line with the studies by Palanisamy (2011). Lack of technical skill to follow PF recommendation constrained the traditional farmers in adoption of PF. Farmers are doing agriculture with their own perceptions and find the new farming technique to be complex.

Inadequate size of landholdings was also a constraint for the adoption of PF because the criteria for selection of farmers for PF were that they should possess at least one hectare individually or jointly. But the farmers in the study area had small land holdings. Infrastructure constraints like unavailability of the machines and tools and the unavailability of local experts to assist were also considered as a main problem faced by the farmers doing PF. Lack of extension support was reported as a constraint in the adoption of organic farming practices. A similar observation was also made by Ramachandran (1997), Sriram (1997) and Sherief (1998). A possible reason may be lack of sufficient extension functionaries to act as facilitators to farmer communication. For this, the agricultural extension specialist should be well acquainted with the locality, the farmers, socio-economic and political interaction within the panchayat. They must know about the different systems and practices present in the village community. For equipping extension specialist to work in this specialized area, it is necessary that they must

be trained in participatory extension methods. And the lack of recommended package of practices for PF handicapped the farmers from following a mechanized way. Package of practices have to be evolved for the major potential vegetable crops. This will facilitate speedy adoption of PF practices. Allan (2000) reported a similar finding.

Lack of marketing facilities was also one of the major constraints perceived by precision farmers. There was no organized union-wide or state-wide marketing infrastructure for the produce. They believed that market tie-ups lead to low price fixation for the produce or unprofitable negotiations. The local market was not sufficient to market the huge quantity of output produced through PF. Researchers and policy makers should think of starting markets for precision farms. The government can procure vegetables from the farmers and sell it on a reasonable rate in the market so that the consumer has a better choice to buy vegetables. This will help the farmers and the consumers alike. A similar finding was observed by Allan (2000).

Other constraints like heavy fluctuation in commodity price, lack of crop insurance, lack of price policy, transportation were also considered as the major constraints hindering PF practices. High labour charges were considered as a constraint by the vegetable growers. Compared to the neighbouring states, the wage rate for labour is relatively higher in Kerala due to the existing socio-political situation. One way to solve this is to train the family members in activities that require skill. Similarly, farmers can look for alternatives that need less external labour in the farm. A similar result was reported by Manjusha (1999) and Majjusha (2000).

HYPOTHESIS TESTING

To test the null hypothesis, correlation analysis was done to check whether there is any significant relationship between the attitude of the respondents and adoption of precision farming practices. The result is given in Table 19.

Table 19: Correlation between attitude and adoption of the respondents

Sl. no	Correlation between attitude and adoption of the respondents	
1	Precision farmers	0.2778*
2	Conventional farmers	0.115079

Note: * Significant at 5% level
** Significant at 1% level

From the table we can conclude that for precision farmers, there is positive and significant relationship between the attitude and the adoption of PF technologies. Hence, the null hypothesis is rejected. But for conventional farmers, there is a positive relationship between the dependent variables; however, they are not significant. So, we can say that the null hypothesis is true – that there is no significant relationship between the attitude of the respondents and the adoption of PF technologies.

Empirical model of the study

Based on the findings of correlation analysis, the empirical model showing the relationship of characteristics of respondents with the dependent variables, namely, attitude and adoption of precision farming practices is depicted in Fig.4 and 5.

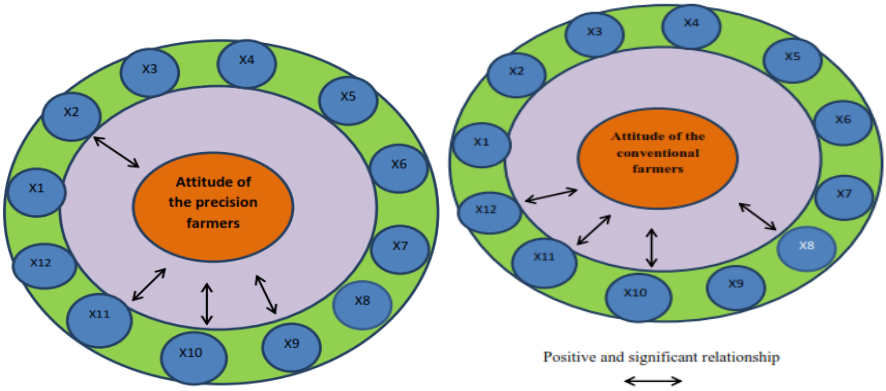

Fig.3. Empirical model showing relationship between attitude and profile characteristics

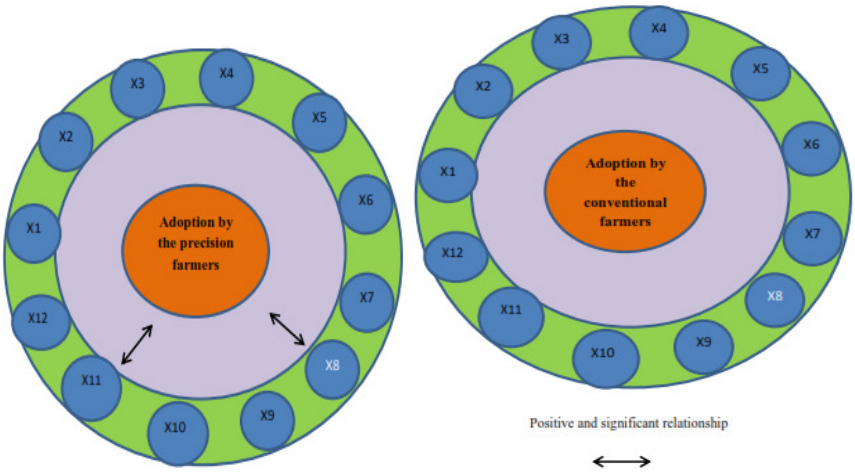

Fig.4. Empirical model showing relationship between adoption and profile characteristics

Conclusion

Based on the findings of this study, certain implications have been drawn which might be useful for scaling up PF practices in the study area and beyond. Economic motivation, scientific orientation and risk orientation were also found to be significant factors for adoption of new and improved technologies. Hence, the economic advantage of PF as compared to conventional farming should be highlighted. The other major factors which had significant and positive relationship with adoption have been extension orientation and trainings undergone. Hence, it is essential that these interventions are also intensified to enable all the respondents to benefit from the practice. Information seeking behaviour, market perception and innovativeness also had a positive impact on the adoption. So, major sources of information like trainings, demonstrations and publications should be provided regularly. Information on market, prices and other aspects will also be helpful. Hence, interventions on these aspects need to be continued and strengthened to benefit all the farmers.

Among the problems and constraints expressed by the PF beneficiaries, non-availability and higher cost of water soluble

fertilizers and other inputs, infrastructural constraints, market imperfection and price fluctuation were found to be important. All these can be collectively addressed if the PF beneficiaries are facilitated and motivated to get organised into registered societies and federated at block and district levels so that such organised and empowered groups would gain bargaining power while purchasing inputs from agro companies directly on one hand and strengthen the production, value addition, and marketing processes effectively to get maximum advantage and benefit. There should be proper linkages among thefarmers, scientists and extension functionaries in order to enhance the adoption levels and it should becontinued and further strengthened among all the stakeholders for sustaining the adoption for positive impacts. Success stories of successful farms and farmers can be motivating to other PF beneficiaries and also general farming community. It needs to be regularly and continuously shared through publications, CDs, websites, newsletter and mass media. Awards may be thought of to recognise the achievers and contributors to promote the spirit of success.

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