Adoption of Agronomic Practice Wise Green Technologies Utilization Behaviourof Trichy and Madurai district farmers in Rice-based Ecosystem

Abstract

The current study was carried out in Madurai and Trichy districts of Tamil Nadu. Two blocks from each district were chosen. For this study, a total sample size of 240 people was used. More than half (60.00%) of the farmers had fully adopted the seed treatment practices in which 62.50 per cent of Trichy district farmers had fully adopted and more than half (57.50%) of Madurai district farmers had fully adopted the above practices. More than three-fourths (83.33%) of the farmers had fully adopted in which 86.66 per cent followed by 80.00 per cent of Trichy and Madurai district farmers had fully adopted the application of farm yard manure respectively.Exactly half of the Trichydistrict respondents (50.00%) had fully adopted summer ploughing followed by 52.50 per cent of Madurai farmers.

Key words:Wise Green Technologies,Ecosystem, Rice,sustainable agriculture

1. Introduction

The term "green technology in agriculture," often known as "sustainable agriculture" or "agtech," refers to a variety of methods, inventions, and tools designed to lessen agriculture's negative effects on the environment while boosting production and efficiency (İnce and Guler, 2020). “Technologies reducing fossil fuel consumption can minimize the energy crisis and reduce the negative impact of agriculture production systems on the environment” (İnce and Guler, 2020).“In spite of considerable primary success, indiscriminate use of mineral fertilizers haveoften led to deterioration in the overall soil health of the country leading to stagnation of foodgrain production” (Indra*et al.* 2014). In order to solve the problems of resource scarcity, climate change, food security and feeding a rising population, agriculture must embrace these green technologies. Newer approaches are needed that will integrate biological and ecological processes into food production, minimize the use of those non-renewable inputs that cause harm to the environment or to the health of farmers and consumers, make productive use of the knowledge and skills of farmers, so substituting human capital for costly external inputs, and make productive use of people's collective capacities to work together to solve common agricultural and natural resource problems, such as for pest, watershed, irrigation, forest and credit management.

Methodology

Extent of utilization of farmers using green technologies can be operationalized as the extent of green technologies adopted by the paddy growers in agronomic practices, main field preparation, pest management, disease management and harvesting. To measure the utilization behaviour of green technologies among the beneficiaries in rice based ecosystem, a scale was developed as suggested by Likert (1932) and Edwards (1957). The methodology used in the development of green technologiesutilizationbehaviour index was given as follows.

1. Collection and editing of items

The various practices followed in green technology were stated and discussed with the experts of Agronomy, Entomology and Pathology. A set of 50 practices were stated and revised according to fourteen criteria given by Thurstone (1946), Likert (1932) and Edwards (1957). After revision, 95 statements were retained and sent forjudges opinion.

2. Relevancy test

The revised 95 statements/ practices were sent forjudges opinion to 120 experts in the field of Agronomy, Entomology, Pathology and senior faculty members of State Agricultural Universities, Programmeco-ordinator, Subject Matter Specialists of KVK, ICAR scientists and scientists related to this domain. They were asked to indicate their grading for each statement as ‘Most Relevant’, ‘Relevant’ and ‘Not relevant’ with the scores of 3, 2 and 1 respectively. They were also requested to include statements if any statement was left out[Deepika et al. 2022]. Hence, a total of 60 members were responded to the index. Based on the responses received, for each statement, the relevancy weightage, relevancy percentage and mean relevancy score was calculated by using the following formula;

i. Relevancy weightage

Indicates the relevancy of the statement to the impact index.

$$RW = \frac{MRR * 3 + RR * 2 + NRR * 1}{MOS\ (3 * 55 = 165)}$$

Where,

RW = Relevancy Weightage
MRR = Most Relevant Response
RR = Relevant Response
NRR = Not Relevant Response
MOS = Maximum Obtainable Score

ii. Relevancy percentage

Indicates the relevant percentage of the statement to the impact index.

$$RP = \frac{OS}{MOS\ (3 * 55 = 165)}\ X\ 100$$

Where,

RP = Relevancy Percentage
OS = Obtained Score
MOS = Maximum Obtainable Score

iii. Mean relevancy score

Indicates the mean relevancy score of each statement to the impact index.

$$MRS = \frac{MRR * 3 + RR * 2 + NRR * 1}{No.of\ Judges\ (55)}$$

Where,

MRS = Mean Relevancy Score
MRR = Most Relevant Response
RR = Relevant Response
NRR = Not Relevant Response

Based on the relevancy percentage (>66%), relevancy weightage (0.66) and mean relevancy score (>2); the final statements were selected.

3. Calculation of 't' value (Item analysis)

The relevant 50 statements were subjected to item analysis to assess the statements based on their ability to differentiate the respondent with high impact and low

impact (extent to differentiate) towards green technology beneficiaries. For this purpose, the selected 50 statements were sent to 60 farmers in non-sample area. The farmers were requested to indicate their response on a five point continuum ranging from 'strongly agree', 'agree', 'undecided', 'disagree' and 'strongly disagree' with the scores of 5,4,3,2 and 1 respectively for positive statements and *vice versa* for negative statements. Based on the responses obtained from the farmers, they were arranged in descending order according to their total scores. As suggested by Edwards (1957), the high group (top 25 per cent of farmers) and the low group (lowest 25 per cent of farmers) were identified to evaluate the individual statements. Finally, out of 60 farmers, the 20 farmers with highest and lowest scores were used as criterion groups to evaluate the individual statements.

As suggested by Edwards (1957), the 't' value is calculated by using the following formula,

$$t = \frac{\overline{X_H} - \overline{X_L}}{\sqrt{\frac{\sum(X_H - \bar{X}_H)^2 + (X_L - \bar{X}_L)^2}{n\,(n-1)}}}$$

Where,

$(X_H - \bar{X}_H)^2 = {X_H}^2 - (X_X)^2$

$(X_L - \bar{X}_L)^2 = {X_L}^2 - (X_L)^2$

X_H = The mean score on given statement of the high group

X_L = The mean score on given statement of the low group

X_H^2 = Sum of square of the individual score on a given statement for high group

X_L^2 = Sum of square of the individual score on a given statement for low group

X_H = Summation of scores on given statement for high group

X_L = Summation of scores on given statement for low group

n = Number of respondents in each group

$\sum$ = Summation

4. Selection of statements for final scale

According to the calculated 't' value, for the 50 statements, the statements with highest 't' value were selected for inclusion in scale. Thus, a total of 36 practices or statement were selected to develop the index; in order to assess the utilization behaviour of green technology among the paddy farmers

Thus, a total of 36 statements with highest 't' values were selected for the construction of the final scale which differentiate between highest and lowest groups. The statements with low 't' value were deleted. The final lists of selected statements were presented in Table.1.

Table 1.AgronomicPractices to assess green technologies utilization behaviour in rice

S. No.	Practices to assess green technologies utilization behaviour in rice	Responses		
		Adopted	**Partially adopted**	**Not adopted**
I	**Agronomic Practices**			
A	**Nursery**			
a)	**Seed treatment :** Azospirillum 3pkt and Phosphobacteria 3 pkts or Azophos 6pkts/kg of seeds – Biofertilizer *Trichoderma sp.* 10g/kg –Biocontrol			
b)	**Sowing:** Area 1/10th of total area			
c)	**Nutrient Management:** Spraying of NSKE extract			
	Water Management: Maintaining 1.5-2.5 cm of water depending on seedling height			
B	**Main field**			
a.	**Main field preparation**			

	Puddling			
	Levelling			
b.	**Organic Manure**			
	Application of FYM / Compost @ 12.5t/ha			
	Incorporation of Green manure @ 6.25 t/ha (Daincha, Sunhemp, Agathi			
c.	**Biofertilizers**			
	Raising Azolla as dual crop			
	Broadcast 10 kg of soil based powdered BGA flakes at 10 DAT			
	Broadcast Azospirillum @ 10 pkts/ha			
d.	**Transplanting:** Transplanting the seedlings at the right age (1 week for 1 month crop duration)			
e.	**Water Management**			
	Avoid Stagnation			
	Alternate wetting and drying – appearance of hairline crack			
f.	**Nutrient Management**			
	Split application of fertilizer			
	Application of nitrogen by using leaf colour chart			
	Apply fertilizer nutrients as per STCR-IPNS			
g.	**Weed management**			
	Usage of clean seeds			
	Summer ploughing			
	Well decomposed and enriched FYM			
	Stale seed bed technique			
II	**Pest Management**			
	Selection of healthy seeds or use of available			

	Raising of bund crops like cowpea and blackgram			
	Ecological Engineering crops like marigold , sunflower			
	Clipping of rice seedlings tips before transplanting			
	Use of botanicals as basal or foliar spray			
	Pheromone traps @15/ha			
	Bird perches @ 15/ha			
	Tanjore bow traps @ 100/ha			
	Release of parasitoids like *T.chilonis* or *T.japonicum*			
	Conservation of biological agents such as spider, waterbug, wasp, dragon fly, damselfly.			
	Early and timely sowing			
	Applications of pesticides based on ETL			
	Proper destruction of straws and stubbles			

2. Results and Discussion

3.1 Practice wise green technologies utilization behaviour of Trichy and Madurai district farmers in rice based ecosystem

The practice wise green technologies utilization behaviour of Trichy and Madurai district farmersin rice-based ecosystem were assessed by using green technologies behaviour index developed for study. The responses were obtained and are given in Table 2.

3.1.1. Agronomic practices

Agronomic practice wise green technologies utilization behaviour of Trichy and Madurai district farmers in rice-based ecosystem is presented in Table 2

Table.2. Agronomic practice wise green technologies utilization behaviour of Trichy and Madurai district farmers in rice-based ecosystem

S. No.	Utilization behavior	Trichy n= 120						Madurai n= 120						Total n= 240					
		Fully Adopted		Partially adopted		Not adopted		Fully Adopted		Partially adopted		Not adopted		Fully adopted		Partially adopted		Not adopted	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No	%	No	%	No	%
I	**Agronomic Practices**																		
A	**Nursery**																		
1	**Seed treatment :** Azospirillum 3pkt and Phosphobacteria 3 pkts or Azophos 6pkts/kg of seeds – Biofertilizer *Trichoderma sp.* 10g/kg – Biocontrol	75	62.50	37	30.83	8	6.67	69	57.50	30	25.00	21	17.50	144	60.00	67	27.91	29	12.08
2	**Sowing:** Area 1/10th of total area	60	50.00	40	33.33	20	16.67	77	64.16	20	16.66	23	19.16	137	57.08	60	25.00	43	17.91
3	**Nutrient Management:** Spraying of NSKE extract	68	56.67	32	26.67	20	16.67	59	49.16	37	30.83	24	20.00	127	52.91	69	28.75	44	18.33
4	**Water Management:** Maintaining 1.5-2.5 cm of water depending on seedling height	80	50.00	24	20.00	16	13.33	75	62.50	20	16.66	25	20.83	155	64.58	44	18.33	41	17.08
B	**Main field**																		
5	**Main field preparation**																		
i.	Puddling	89	74.16	14	11.66	17	14.16	78	65.00	18	15.00	24	20.00	167	69.58	32	13.33	41	17.08
ii.	Levelling	72	60.00	28	23.33	20	16.66	66	55.00	25	20.83	29	24.16	138	57.50	53	22.08	49	20.42

6	**Organic Manure**																		
i.	Application of FYM / Compost @ 12.5t/ha	104	86.66	10	8.33	6	5.00	96	80.00	12	10.00	12	10.00	200	83.33	22	9.17	18	7.50
ii.	Incorporation of Green manure @ 6.25 t/ha (Daincha, Sunhemp, Agathi	62	51.66	30	25.00	28	23.33	45	37.50	33	27.50	42	35.00	107	44.58	63	26.25	70	29.17
7	**Biofertilizers**																		
i.	Raising Azolla as dual crop	45	37.50	36	30.00	39	32.50	27	22.50	49	40.83	44	36.66	72	30.00	85	35.42	83	34.58
ii.	Broadcast 10 kg of soil based powdered BGA flakes at 10 DAT	28	23.33	70	58.33	22	18.33	35	29.16	50	41.66	35	29.16	63	26.25	120	50.00	57	23.75
iii.	Broadcast Azospirillum @ 10 pkts/ha	83	69.16	21	17.5	16	13.33	76	63.33	24	20.00	20	16.66	159	66.25	45	18.75	36	15.00
8	**Transplanting:** Transplanting the seedlings at the right age (1 week for 1 month crop duration)	87	72.50	20	16.66	13	10.88	97	80.83	16	13.33	7	5.83	184	76.67	36	15.00	20	8.33
9	**Water Management**																		
i.	Avoid Stagnation	56	46.67	44	36.67	20	16.67	34	28.33	50	41.66	36	30.00	90	37.50	94	39.17	56	23.33
ii.	Alternate wetting and drying – appearance of hairline crack	20	16.67	80	66.67	20	16.67	29	24.16	60	50.00	31	25.83	49	20.42	140	58.33	51	21.25
10	**Nutrient Management**																		
i.	Split application of fertilizer	60	50.00	40	33.33	20	16.66	59	49.16	46	38.33	15	12.50	119	49.58	86	35.83	35	14.58
ii.	Application of nitrogen by using leaf colour chart	16	13.33	44	36.67	60	50.00	20	16.66	27	22.50	73	60.83	36	15.00	71	29.58	133	55.42
iii.	Apply fertilizer nutrients as per STCR-IPNS	24	20.00	36	30.00	60	50.00	32	26.66	39	32.50	49	40.83	56	23.33	75	31.25	109	45.42
11	**Weed management**																		
i.	Usage of clean seeds	76	63.33	24	20.00	20	16.67	70	58.33	28	23.33	22	18.33	146	60.83	52	21.67	42	17.50
ii.	Summer ploughing	60	50.00	40	33.33	20	16.67	63	52.50	29	24.16	28	23.33	123	51.25	69	28.75	48	20.00
iii.	Well decomposed and enriched FYM	89	74.16	19	15.83	12	10.00	81	67.50	15	12.50	24	20.00	170	70.83	34	14.17	36	15.00
iv.	Stale seed bed technique	36	30.00	68	56.67	16	13.33	19	15.83	42	35.00	59	49.16	55	22.92	110	45.83	75	31.25

12	**Pest Management**																		
i.	Selection of healthy seeds or use of available	52	43.33	56	46.67	12	10.00	83	69.16	21	17.50	16	13.33	135	56.25	77	32.08	28	11.67
ii.	Raising of bund crops like cowpea and blackgram	64	53.33	32	26.66	24	20.00	48	40.00	27	22.50	45	37.50	112	46.67	59	24.58	69	28.75
iii.	Ecological Engineering crops like marigold , sunflower	24	20.00	44	36.67	52	43.33	18	15.00	21	17.50	81	67.50	42	17.50	65	27.08	133	55.42
iv.	Clipping of rice seedlings tips before transplanting	64	53.33	36	30.00	20	16.67	70	58.33	31	25.83	19	15.83	134	55.83	67	27.92	39	16.25
v.	Use of botanicals as basal or foliar spray	32	26.67	68	56.67	20	16.67	75	62.50	29	24.16	16	13.33	107	44.58	97	40.42	36	15.00
vi.	Pheromone traps 15/ha	52	43.33	24	20.00	44	36.66	69	57.50	19	15.83	32	26.66	121	50.42	43	17.92	76	31.67
vii.	Bird perches @ 15/ha	60	50.00	44	36.66	16	13.33	73	60.83	29	24.16	18	15.00	133	55.42	73	30.42	34	14.17
viii.	Tanjore bow traps @ 100/ha	20	16.67	48	40.00	52	43.33	13	10.83	21	17.50	86	71.66	33	13.75	69	28.75	138	57.50
ix.	Release of parasitoids like *T.chilonis* or *T.japonicum*	64	53.33	16	13.333	40	33.33	72	60.00	23	19.16	25	20.83	136	56.67	39	16.25	65	27.08
x.	Conservation of biological agents such as spider, waterbug, wasp, dragon fly, damselfly.	68	56.66	20	16.66	32	26.66	38	31.66	16	13.33	66	55.00	106	44.17	36	15.00	98	40.83
xi.	Early and timely sowing	64	53.33	40	33.33	16	13.33	58	48.33	34	28.33	28	23.33	122	50.83	74	30.83	44	18.33
xii.	Applications of pesticides based on ETL	24	20.00	72	60.00	24	20.00	20	16.66	67	55.83	33	27.50	44	18.33	139	57.92	57	23.75
xiii.	Proper destruction of straws and stubbles	72	60.00	44	36.67	4	3.33	60	50.00	36	30.00	24	20.00	132	55.00	80	33.33	28	11.67

From the above Table 2 , it could be understood that among the nursery components of agronomic practices more than half (60.00%) of the farmers had fully adopted the seed treatment practices in which 62.50 per cent of Trichy district farmers had fully adopted and more than half (57.50%) of Madurai district farmers had fully adopted the above practice. Biofertilizers like *Azospirilum* and *Phosphobacteria*were provided by the State Department of Agriculture through subsidies to the farmers which might be the reason for the adoption of seed treatment practices. The findings are in line with Rathod.*et.al.*,(2017)

Regarding application of organic manures in main field preparation, more than three-fourths (83.33%) of the farmers had fully adopted in which 86.66 per cent followed by 80.00 per cent of Trichy and Madurai district farmers had fully adopted the application of farm yard manure respectively. The availability of livestock possessed by the farmers in both the districts helped them to make use of the organic manures in their fields which in turn increased the soil capacity and hold more water and nutrients.

A little more than one-third (35.42%) of the farmers had partially adopted raising of Azolla as dual crop in which 30.00 per cent and less than half (40.83 %) of Trichy and Madurai district farmers had partially adopted raising of Azolla as dual crop respectively. Though the farmers were provided with free Azolla seeds and trainings imparted by the NGOs and Department officials, majority of the farmers could not raise azolla as sometimes it got dried due to excess heat. The non-availability of family labour to maintain the tank resulted in poor growth of Azolla. This might be the probable reasons for partial adoption of azolla.

From the Table no 1, it is clear that two-thirds of the respondents (66. 25%) had fully adopted *Azospirillum* as biofertilizer in their main field preparation followed by 69.16 per cent and 63.33 per cent of Trichy and Madurai district farmers respectively. The easy availability of *Azospirillum*biofertilizer encouraged the farmers to apply in their fields. Moreover, this biofertilizer can be used for many purposes starting from seed treatment, field application etc. The use of biofertilizer helps to minimize the use of chemical fertilizer which inturn helps to enhance the utilization of green technologies.

More than one-third (39.17 %) of the farmers had partially adopted water management practices (avoiding stagnation). In Trichy, more than one-third (36.17%) of the farmers and in Madurai, 41.66 per cent of the farmers had partially adopted the above mentioned practice. More than half (58.33%) of the farmers had partially adopted alternate wetting and drying practice in which 66.67 per cent and 50.00 per cent of Trichy and Madurai district farmers had partially adopted the alternate wetting and drying practice respectively.

Little less than half (49.58%) of the farmers had fully adopted the spilt application of fertilizers followed by exactly half (50.00 %) of the Trichydistrict farmers and 49.16 per cent of Madurai district farmers had fully adopted the practice of split application of fertilizers. Majority of the farmers were aware of split application. Instead of applying the fertilizers at whole in starting stages would suppress the growth. By splitting and applying it whenever needed, would provide nitrogen requirements at right time irrespective of crops. Split application play an important role in nutrient management that is productive, profitable and environmentally responsible. The trainings and demonstration provided by the support system encouraged the farmers to fully adopt this split application among the farmers.

More than half (55.42%) farmers had not adopted application of nitrogen by using colour leaf chart in which 60.00 percent of Trichy district farmers and 60.83 per cent of Madurai district farmers had not adopted. N application at the right time and right amount is critical for healthy plant and environment. Rice leaf color intensity is directly related to leaf chlorophyll amount and leaf nitrogen status. Though the leaf colour chart is easily affordable, it is not that much popular among the farmers and there is difficulty faced by the farmers in determining the nitrogen doses.

It is obstensible from the Table no. 2 that exactly half of the Trichy district farmers (50.00%) had not adopted the application of fertilizer nutrients as per Soil Test Crop Response - Integrated Plant Nutrient System (STCR-IPNS) followed by 40.83 per cent of Madurai district farmers had not adopted. Lack of awareness and knowledge on STCR-IPNS is likely to be the reason for the non-adoption.

Less than two-thirds of the farmers (60.83%) had fully adopted usage of clean seeds in which 63.33 per cent of Trichy farmers and 58.33 per cent of Madurai farmers had fully adopted. Farmers were very much conscious in sowing the clean seeds in order to avoid weeds in their

fields. For obtaining healthy and weed-free crop, healthy and clean seeds should be used. This helps to avoid not only the weeds but also helps in avoiding seed-borne diseases.

The findings of the study is in contrast to findings of Guna and Vengatesan (2019)

Exactly half of the Trichydistrict respondents (50.00%) had fully adopted summer ploughing followed by 52.50 per cent of Madurai farmers. Less than three-fourths (70.83%) of the farmers had fully adopted well-decomposed and enriched FYM in which 74.16 per cent of Trichy farmers and 67.50 per cent of Madurai district farmers had fully adopted well-decomposed FYM. Less than half of the respondents (45.83%) had partially adopted stale seed bed technique in which 56.67 per cent of Trichy farmers and 35.00 per cent of Madurai farmers had partially adopted. Stale seed bed technique requires more labour cost and also a time-consuming process. The lack of awareness on stale seed bed technique also might be the reason for partial adoption.

The findings are in support with Suji and Kumar (2020)

More than half (56.25%) of the respondents had fully adopted the selection of seeds for pest management in which 43.33 per cent and 69.16 per cent of Trichy and Madurai district farmers respectively had fully adopted the practice. More than half (53.33%) of Trichy farmers had adopted raising of bund crops in order to avoid pests in their fields. In Madurai district, 40.00 per cent of the farmers had fully adopted the above practice. Raising bund crops like cowpea and black gram avoids pests and also generates additional income for the farmers. This might be the reason for adoption of bund crops.

More than half of the Trichydistrict farmers (53.33%) had fully adopted followed by 58.33 per cent of Madurai district farmers had fully adopted the clipping of rice seedling clips before transplanting. 44.58 per cent of farmers had fully adopted the use of botanicals as foliar or basal spray in which 26.67 per cent of Trichydistrict farmers followed by less than two-thirds (62.50%) of Madurai district farmers had fully adopted the above practice. The adoption of the mentioned practice is more prevalent in Madurai district as they were very much encouraged by the Department officials and NGOs in utilizing the available botanicals to provide safety to natural enemies in rice ecosystem. It was observed that half of the respondents (50.42%) had fully adopted pheromone traps for managing pests in which 43.33 per cent of

Trichydistrictfarmers and 57.50 per cent of Madurai district farmers had fully adopted. 55.42 per cent of the farmers had fully adopted the bird perches in which exactly half (50.00%) of Trichy farmers and 60.83 per cent of Madurai farmers had fully adopted.

More than half (57.50%) of the farmers had not adopted Tanjore bow traps in which 43.33 per cent and 71.66 per cent of Trichy and Madurai district farmers respectively had not adopted the above practice. More than half (53.33%) of the Trichydistrict respondents had fully adopted the release of parasitoids followed by 60.00 per cent of Madurai district farmers.

Conclusion

The availability of parasitoids in bio control unit in Madurai district made the farmers to purchase the parasitoids through subsidies. The frequent contact of AO officials with farmers encouraged them to adopt the practice.

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