Original Research Article

ADOPTION OF RECOMMENDED FERTILIZER DOSE IN FARMER'S FIELD OF BANGLADESH

ABSTRACT

The study was conducted to explore the farmer's level of adoption of recommended fertilizer dose in the field. A survey was conducted at Batiaghata upazila of Khulna, Bangladesh during January to February in 2019 on purposive randomly selected 120 respondents in respect of selected twelve variables. The selected variables (characteristics of the respondents) were age, educational qualification, family size, farming experience, annual family income, farm size, organizational participation, agricultural training, cosmopolitanism, extension contact, attitude and practice. Two aspects of adoption i.e., innovativeness (time dimension) and extent of adoption (spatial dimension) of recommended fertilizer dose were considered as the focus variables. Data analysis was performed using SPSS (Statistical Package for Social Science) software version 20.0. To explore the relationship between the concerned variables Pearson's Product Moment Coefficient of Correlation (r) for ratio data and Spearman's Rank Order Correlation Coefficient (ρ) for ordinal data were employed. The result showed that majority of the respondents were old aged (41.7%), had secondary level of education (56.70%), belonged to small family size (50%), had high annual family income (66.7%) and high farming experience (40%) with small farm size (76.67%). Majority of the respondents had low organizational participation (44.16%), low contact with extension agent (57.5%) and medium cosmopolitanism (57.5%) and had no agricultural training (59.2%). Findings also revealed that majority of the respondents (62.5%) showed high positive attitude towards adoption of recommended fertilizer dose. About half of the respondents (43.3%) belonged to medium practice category of recommended fertilizer dose in the field. Considering the innovativeness still 45.83% of the respondents belonged to late majority to laggard category of innovation diffusion, and still 36.66% land is not under recommended fertilizer dose application which significantly differ from the amount of land under recommended fertilizer dose application. Among 120 respondents there was no innovator. Among twelve variables age and farming experience had significant positive relation with their innovativeness, and educational qualification, annual family income, farm size and extension contact had significant positive relation with their extent of adoption of recommended fertilizer dose. Thus, it might be concluded that, the remaining farmers should be motivated to adopt and the remaining land should be practically taken under proper application of recommended fertilizer dose to sustain agricultural production in the field.

Keywords: *Recommended fertilizer dose (RFD), Adoption, Innovativeness, Agricultural practice.*

1. INTRODUCTION

Bangladesh is one of the most densely populated countries of the world. It has favorable climate for the production of variety of crops. Per capita cultivable land in the country is about 0.2 acres, which is one of the lowest in the world [1].To meet the food grain requirement for the growing population with limited land resources; pressure on land is increasing. The farmers use chemical fertilizers as a supplemental source of nutrients but they do not apply in balanced proportion [2]. The organic matter content of Bangladesh soils continuously decreased [3]. A recent roundtable meeting on "balanced fertilizer usage" organized by

"The Daily Star" [4] reported that the majority of Bangladeshi farmers did not follow fertilizer recommendation guides. They were also unwilling to perform or rely upon soil tests and explicitly prepared recommendation so the required amount of fertilizers they needed, and instead put faith in tacitly acquired traditional farming experience and knowledge [4].

In our country farmers are using excess fertilizer and irrigation which are expensive and these are the threat for soil and the environment. On the other hand, less fertilizer and irrigation also risk for getting optimum or desired yields. However, today chemical fertilizer has become essential to modern agriculture, but they have many negative consequences and have beyond the reach of ordinary farmers. For instance, [5] reported that chemical fertilizers and pesticides contribute greatly to enhance soil fertility, and they are also major sources of farmland pollution and contamination. [6] reported that, far from being life sustaining, our modern chemical dependent farming methods strips the soil of nutrients, destroys critical soil microbes, contributes to desertification and climate change and saturates farmlands with toxic pesticides, herbicides, and fertilizers that then migrates into groundwater, rivers, lakes and oceans. Repeated applications may result in a toxic buildup of chemicals such as arsenic, cadmium, and uranium in the soil. Despite the harmful effects of chemical fertilizers, farmers in Bangladesh rely heavily on the use of chemical fertilizers to increase crop yield because soil nutrients have been depleted due to incessant continuous tillage. Environmental degradation is another consequence associated with current agricultural practices of Bangladesh. For maintaining of soil quality and attainable crop yield, it is required to add proper amount of fertilizers and minimize the misuse of soil resources.

Evidence shows that among the farmers who apply fertilizer in their fields, majority of them apply at very low level [7]. This culminates into inadequate food production for the rapid growing population. Several factors have been associated with the adoption behavior. These are the independent factors like personal, institutional, environmental and socioeconomic factors [8], [9] and [10]. The intervening variables are the key determinants of the adoption behavior. Factors affecting adoption include age, education, sex, household size, landholding size [11] and [12], awareness, income [13], experience, risk and uncertainties [14], innovation attributes like compatibility, trialability, relative advantage [15], and membership in FFS [16]. Adoption is influenced by various factors, some of them include awareness or access to information, income/wealth and access to credit [17] and [18]. Although farmers know about the recommended fertilizer dose but they merely practice it on their own field. What is their real perception towards adoption of recommended fertilizer dose! This research was conducted to find out the reason behind this. In the light of the above facts, this study was aimed to satisfy the following objectives: a) to analyze some of the selected characteristics of the farmers' towards adoption of recommended fertilizer dose, b) to assess farmers' attitude and practice regarding recommended fertilizer dose, c) to determine the extent of adoption and innovativeness regarding recommended fertilizer dose, and d) to explore the relationship between selected characteristics of the farmers and their extent of adoption and innovativeness regarding recommended fertilizer dose.

2. METHODOLOGY

2.1 Data Collection

Descriptive and diagnostic research design was followed in this research [19]. A descriptive research design was used for fact-findings with adequate interpretation. A sample of 120 respondents was selected in seven unions (Amirpur, Gangarampur, Jalma, Batiaghata, Baliadanga, Bhanderkote

and Surkhali) of Batiaghata Upazila in Khulna District. All the farmers of the seven unions, who were involved in crop production in the field, had been considered as the population of the study. The sample number (120) was decided purposively for the ease of data handling due to logistics limitation. Then, proportionate number of respondents was selected from those seven unions to fulfill the number of 120. During selecting the samples the enumerator practiced randomization and remained unbiased. The primary data were collected through face to face interview from 20th of January to 15th of February in 2019. After completion of survey all the interview schedules were compiled for data processing. All the qualitative data were converted into quantitative form by means of suitable code and score whenever necessary. In several instances indices and scales were constructed through the simple accumulation of scores assigned to individual or pattern of attributes. Indices and scales were considered the efficient instrument for data reduction and analysis.

2.2 Measurement of variables

2.2.1 Independent variables

In this study selected characteristics of the respondents were considered as independent variables such as age of the respondents, family size, and educational qualification, farming experience, organic farming experience, annual family income, farm size, organizational participation, agricultural training, cosmopolitanism, extension contact, attitude and practice. The selected characteristics of the respondents were computed following standard procedures as used by [20] and [21].

2.2.2 Dependent variables

Two aspects of adoption i.e., innovativeness (time dimension) and extent of adoption (spatial dimension) of recommended fertilizer dose for the respondents were considered as the dependent variables.

Innovativeness is the degree to which an individual is earlier to adopt an innovation than other members of the social system. The innovativeness of the respondents about recommended fertilizer dose using was determined on the basis of time required to adopt recommended fertilizer dose from first hearing to final adoption of it [21].

Categories	Range
Innovator	< ($\bar{X}$- 2Sd)
Early Adopter	($\bar{X}$-2sd) to ($\bar{X}$-Sd)
Early Majority	($\bar{X}$ – Sd) to ($\bar{X}$)
Late majority	($\bar{X}$) to ($\bar{X}$+Sd)
Laggard	> ($\bar{X}$+2Sd)

The extent of adoption of recommended fertilizer dose was measured by percentage of area coverage by recommended fertilizer dose by using the following formula:

$$\text{Extent of Adoption (\%)} = \frac{A_a}{P_a} \times 100$$

Where

A_a= Actual area of adoption of recommended fertilizer dose

P_a = Potential area for adoption of recommended fertilizer dose

Adoption of recommended fertilizer dose was expressed in decimal.

2.3 Data analysis

Data analysis was performed using the SPSS (Statistical Package for Social Science) software version 20.0. Statistical treatments such as range, mean, standard deviation, maximum, minimum, rank order etc. were used to interpret data. To explore relationship between the variables Pearson's Product Moment Coefficient of Correlation (r) for ratio data and Spearman's Rank Order Correlation Coefficient (ρ) for ordinal data were employed. Five percent (0.05) level of probability was the basis for rejecting any null hypothesis throughout the study.

3. RESULTS AND DISCUSSION

3.1 Selected Characteristics of the Respondents

It has been noticed from the Table 1 that 23.3% respondents were young, 35% respondents were middle aged and 41.7% respondents were old. The age of the respondents ranged from 23 to 102 with a mean of 48 and standard deviation of 14.54.

Among 120 respondents 0.8% respondent was illiterate, 1.7% respondents could sign only their name and 20% respondents had primary level of education. 56.7% respondents had secondary level of education. 9.10% respondents had higher secondary level of education. 10% respondents completed bachelor degree and 1.7% respondents had their education up to mater degree. Here mean value is 6.62 while standard deviation is 3.98, minimum educational level is illiterate which is scored as 0and maximum educational level of the respondents were master degree (Table 1).

From the Table 1 family size of the respondents could be revealed, where 50% respondents belonged to small family, 40% respondents belonged to medium family and 10% respondents belonged to large family. Here mean score is 4.97 and standard deviation is 2.26. Lowest number of family member was 2 and highest number of family member was 16.

The distribution of the respondents according to their farming experience was given in Table 1. Farming experience of the respondents ranged from 2 to 70 years with a mean of 20.79 and standard deviation of 11.94. Highest number (40%) of respondents had high farming experience followed by medium farming experience (39%) and only 21% respondents had low farming experience.

Table 1 contained distribution of the respondents according to their annual income. Annual family income of the respondents ranged from 60,000 to 10,90,000 with a mean of 2,76,878.8 and standard deviation of 1,95,382.67. Data revealed that the majority (66.7%) of the respondents had higher income while 27.5% had medium income. Only 5.8% of the respondents had low income.

The observed farm size scores of the respondents varied from 0.05 ha to 11.81 ha. The average farm size was 0.67 ha and the standard deviation is 1.11 (Table 1).

The observed organizational participation of the respondents ranged from 0 to 12 with a mean of 2.97 and standard deviation of 3.05. Highest proportion (44.16%) of the respondents had low organizational participation followed by high organizational participation (38.34%). On the other hand 17.5% had medium organizational participation (Table 1).

From the Table 1 training experience of the respondents could be explored. Training scores (number) of the respondents ranged from 0 to 4 with a mean of 0.6 and standard deviation of 0.85. Based on the number of training received respondents were grouped into 4 groups. The majority of the respondents (59.2%) had no training while two fifth (40%) of them had low training and only 0.8% respondents received medium training.

From Table 1 cosmopolitanism characteristic of the respondents could be explored. Majority (57.5%) of the respondents had

medium cosmopolitanism followed by high cosmopolitanism (39.2%) while only 3.3% had low cosmopolitanism. Mean of the cosmopolitanism was 15.74 and standard deviation was 3.65. Minimum score of the respondents' cosmopolitanism was 5 while maximum score of the respondents' cosmopolitanism was 23.

Table 1 revealed that majority (57.5%) of the respondents had low contact while 37.5% had medium extension contact and only 5% had high extension contact. The mean of the extension contact was 11.9 and the standard deviation was 6.26. The lowest score of extension contact was 9 while the highest score was 30. It can be said that it is a drawback of the Department of Agricultural Extension (DAE). It also includes internet use. It's a matter of great regret that our farmers are lagging behind in the sector of using internet.

Table 1 showed the distribution of the respondents according to their attitude. Here 3.3% showed negative attitude, 34.2% showed moderately positive attitude and 62.5% showed positive attitude. Mean score was 37.96 and standard deviation was 3.99. The minimum score of attitude of the respondents was 8, on the other hand maximum score was 47.

Majority of the respondents (56.7%) showed high practice followed by medium practice (43.3%). None of them belong to low practice. Practice score of the respondents ranged from 19 to 42 with mean of 31.52 with a standard deviation of 5.12.

Table 1.Distribution of the respondents according to selected characteristics

Parameter	Category	Score	Respondents (N=120)		Mean	SD.	Min.	Max.
			Number	Percentage				
Age (Years)	Young	≤35	28	23.3	48	14.54	23	102
	Middle	36-55	42	35				
	Old	>55	50	41.7				
Educational qualification (Schooling years)	Illiterate	0	1	0.8	6.62	3.98	0	16
	Sign	0.50	2	1.7				
	Primary	1-5	24	20				
	Secondary	6-10	11	9.2				
	HSC	11-12	68	56.7				
	BSc	13-16	12	10				
	MSc	>16	2	1.7				
Family size (No. of members)	Small	≤4	60	50	4.97	2.26	2	16
	Medium	5-7	49	40				
	Large	>7	11	10				
Farming experience (Years)	Low	≤10	25	21	20.79	11.94	2	70
	Medium	10-20	47	39				
	High	>20	48	40				
Annual income (BDT)	Low	≤120000	7	5.8	2768 78.8	1953 82.67	60000	1090 000
	Medium	120001-180000	33	27.5				
	High	>180000	80	66.7				
Farm size	Landless	<0.02	0	0				

(ha)	Marginal	0.02-0.20	18	15	0.67	1.11	0.05	11.81
	Small	0.21-1.0	92	76.67				
	Medium	1.01-3.0	8	6.67				
	Large	>3	2	1.66				
Organizational Participation	Low	≤6	53	44.16	2.97	3.05	0	12
	Medium	7-12	21	17.5				
	High	>12	46	38.34				
Agricultural training (No. of training)	No	0	71	59.2	0.6	0.85	0	4
	Low	≤3	48	40				
	Medium	4-5	1	0.8				

Table 1.Continued…

Parameter	Category	Score	Respondents (N=120)		Mean	SD.	Min.	Max.
			Number	Percentage				
Cosmopolitanism	Low	≤8	4	3.3	15.74	3.65	5.00	23
	Medium	9-16	69	57.5				
	High	>16	47	39.2				
Extension contact	Low	≤11	69	57.5	11.90	6.26	9	30
	Medium	12-22	45	37.5				
	High	>22	6	5				
Attitude	Low	≤28	4	3.3	37.96	3.99	8	47
	Medium	29-44	41	34.2				
	High	>44	75	62.5				
Practice	Low	≤10	0	0	31.52	5.12	19	42
	Medium	11-20	52	43.3				
	High	>20	68	56.7				

3.2 Extent of Adoption of Recommended Fertilizer Dose in Crop Field

From the Fig. 1 extent of adoption (spatial dimension) of Recommended Fertilizer Dose (RFD) the respondents in crop field could be revealed. T-test (two samples assuming unequal variances) was done in which difference between potential area under recommended fertilizer dose and actual area under recommended fertilizer dose was revealed. The land area was measured in decimal, because the large units, e.g., ha, may appear with very small numeric values. The mean of respondents' total land was 152.34 decimal, while the mean of the total land under recommended fertilizer dose was 96.48 decimal. This information was compiled by asking the respondents about their total amount of land under cultivation and in how much of the land they use recommended fertilizer dose. The value of the T-test is 2.05358E-06 (for one tailed) and 4.10716E-06 (for two tailed) which is significant. In 36.66% area of land (i.e., 62.48 decimal), the respondents didn't apply recommended fertilizer dose, which is a huge area of land. This land should be taken under recommended fertilizer dose which may help the respondents to get maximum potential yield.

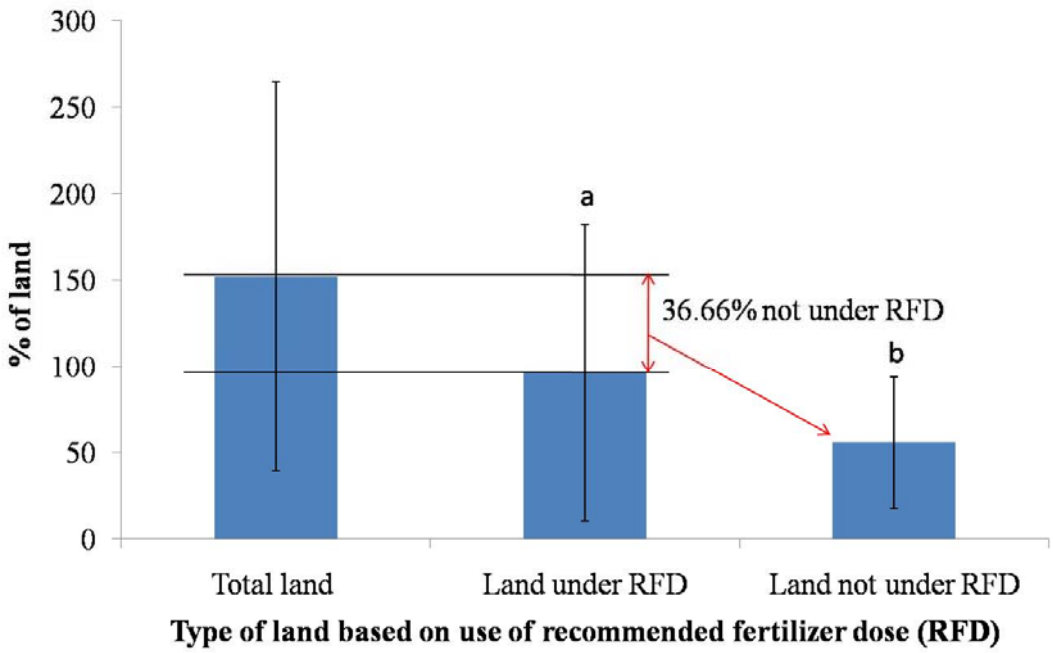

Fig.1. Extent of adoption of fertilizer in field

3.3 Innovativeness of the Respondents

After observing adoption of the respondents a Table of innovativeness of the respondents was prepared (Table 2). Among 120 respondents highest number (45, i.e., 37.5%) of respondents belong to early majority group followed by late majority (38, i.e., 31.67%). 17 respondents (14.16%) were laggard while only 20 respondents (16.67%) were early adopter. None of them belonged to innovator category. A comparison between research findings and Rogers's diffusion of innovation curve (Fig. 2) [15] was done to justify and compare the present findings. Diffusion of innovations is a theory that seeks to explain how, why, and at what rate new ideas and technology spread. Rogers [15] proposes that four main elements influence the spread of a new idea: the innovation itself, communication channels, time, and a social system. The categories of adopters are innovators, early adopters, early majority, late majority, and laggards. According to the Rogers's diffusion of innovation [15] curve 2.5% will be innovators, 13.5% will be early adopters, 34% will be early majority, 34% will be late majority and 16% will be laggard. According to the present research findings none of the respondents were innovator, 16.67% were early adopter, 37.5% were early majority, 31.67% were late majority and 14.16% were laggards. From the Fig. 2 it was seen that 31.67% and 14.16% were late majority and laggard respectively. These respondents should be motivated to adopt recommend fertilizer dose to increase yield.

Table 2. Distribution of the respondents according to their innovativeness

Categories	Range	Score	Number	%	Roger's Curve %
Innovator	<($\bar{x}$-2sd)	**<0.8**	**0**	**0%**	**2.5%**

Early adopter	($\bar{x}$-2sd) to($\bar{x}$-sd)	**0.8-6.5**	**20**	**16.67%**	**13.5%**
Early majority	($\bar{x}$-sd) to($\bar{x}$)	**6.6-12.2**	**45**	**37.50%**	**34%**
Late majority	($\bar{x}$) to ($\bar{x}$+sd)	**12.3-18.7**	**38**	**31.67%**	**34%**
Laggard	>($\bar{x}$+sd)	**>18.7**	**17**	**14.16%**	**16%**

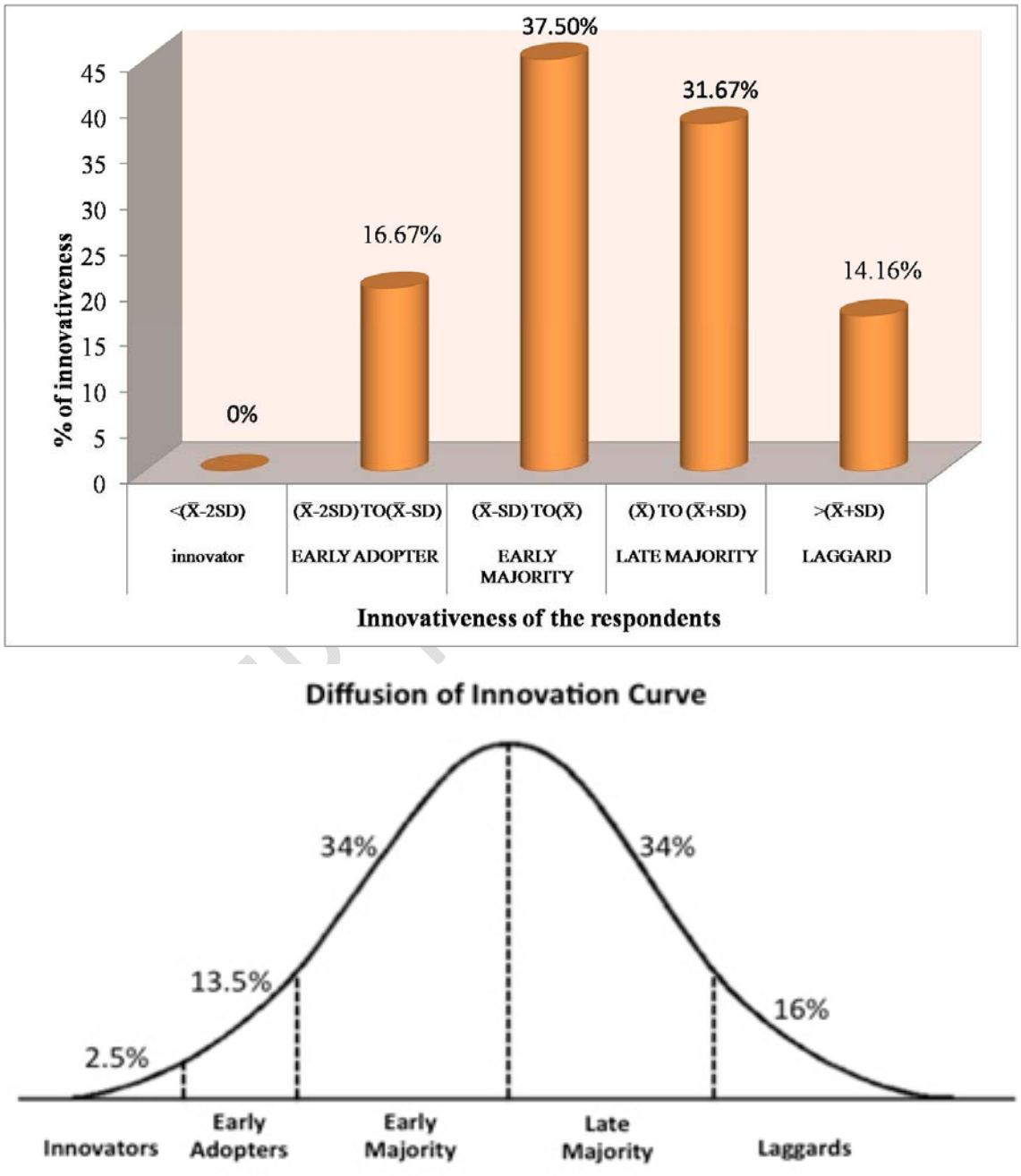

Fig.2. comparison between Roger's diffusion of innovation curve, and innovativeness of the respondents according to findings

3.4 Relationship of the Selected Variables

Correlation coefficient is a numerical measure of some type of correlation, meaning a statistical relationship between two variables. Coefficient of correlation was computed in order to explore the relationship between the twelve selected characteristics of the respondents and their innovativeness and extent of adoption of recommended fertilizer dose. This correlation has been done by using Spearman's Rank Order Correlation Coefficient (ρ) as well as Person's Product Moment Correlation Coefficient (r). Here for age, education, family size, farming experience, annual income, and farm size Pearson's Product Moment Correlation was used because these are ratio type of data. For other variables, that means organizational participation, agricultural training, cosmopolitanism, extension contact, attitude and practice Spearman's Rank Order Correlation Coefficient was computed. From the Table 3 it has been seen that there was significant positive correlation between age and farming experience with respondents' innovativeness. That means the more the age, the more the innovativeness will grow. Also the greater the experience, the higher it will be to innovate. While other ten variables named education, family size, annual income, farm size, organizational participation, agricultural training, attitude and practice had no significant relationship with their innovativeness. Since maximum respondents had small family size, secondary level of education and high annual income they were limited in traditional process of fertilizer application. The computed value of correlation coefficient of education, farm size and annual income had non-significant negative relationship with innovativeness of the respondents.

It was also seen from the Table 3 that, education, farm size, annual income, agricultural training and extension contact had positive significant relationship with respondent's adoption out of twelve variables. One variable named organizational participation had non-significant negative relation with adoption of recommended fertilizer dose. Many respondents were involved in NGO which gave them loan in low interest for short term to bring economic solvency in their life, which does not influence them to adopt new technology, e.g., adoption of recommended fertilizer dose in the field.

Table 3. Relationship of the selected variables between innovativeness and adoption of recommended fertilizer dose of the respondents

Serial	Variables	Innovativeness	Adoption	Correlation Type
1.	Age	0.20*	0.07^{NS}	r
2.	Education	-0.005^{NS}	0.18*	r
3.	Family Size	-0.27^{NS}	0.05^{NS}	r
4.	Farming Experience	0.33**	0.05^{NS}	r
5.	Annual Income	-0.45^{NS}	0.45**	r
6.	Farm Size	$-.04^{NS}$	0.97**	r
7.	Organizational Participation	0.04^{NS}	-0.07^{NS}	ρ
8.	Agricultural Training	0.01^{NS}	0.20*	ρ
9.	Cosmopolitanism	0.10^{NS}	0.10^{NS}	ρ
10.	Extension Contact	0.00^{NS}	0.29**	ρ
11.	Attitude	0.09^{NS}	0.13^{NS}	ρ
12.	Practice	0.11^{NS}	0.16^{NS}	ρ

*: correlation is significant at the 0.05 levels (2tailed); **: correlation is significant at the 0.01 level (2tailed);
r: Pearson's Product Moment Correlation Coefficient; ρ: Spearman's Rank Order Correlation Coefficient;
NS: Non significant

4. CONCLUSIONS

Based on the socioeconomic background of the respondents it could be concluded that the comparatively aged respondents had adopted recommended fertilizer dose having secondary level of education. Majority of the respondent's belonged to small size of family. Majority of the respondents had high farming experience and small farm size. However, they had high annual income. On the basis of the finding it might be concluded that the respondents had low organizational participation, low contact with extension agent, and low facilities for agricultural training. Based on the correlation analysis it could be concluded that old aged and high farming experienced respondents are more innovative. Since maximum respondents had small family size, secondary level of education and high annual income they were limited in traditional process of fertilizer application that means they are less innovative. Education, farm size, annual family income, agricultural training and extension contact had positive significant relation with adoption of recommended fertilizer dose while organizational participation had non-significant negative relation with their adoption since maximum respondents had low organizational participation. Considering the innovativeness still 45.83% of the respondents belonged to late majority to laggard category of innovation diffusion, and still 36.66% land is not under recommended fertilizer dose application which significantly differ from the amount of land under recommended fertilizer dose application.

5. RECOMMENDATIONS

It might be recommended that, proper extension measures should be formulated for the farmers who do not use recommended fertilizer dose in their fields, and they should be motivated to adopt it and the remaining land which are not under application of adequate doses should be practically taken under proper application of recommended fertilizer dose to increase and sustain agricultural production in the field.

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