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Impact of *Trichoderma* Enhanced Composting Technology on Farmers' Livelihoods in Bangladesh

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Authors' contributions

This work was carried out in collaboration between all authors. Author MAM designed the study, developed the conceptual framework, conducted field experiment, collected research data and wrote the first draft of the manuscript. Author MNI wrote the protocol, supervised the research work, performed the statistical analysis and review the manuscript. Authors NM and MRI collected secondary data and review articles for the research. All authors read and approved the final manuscript.

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ABSTRACT

Trichoderma is an environment friendly soil borne fungus that speeds up decomposition of organic materials into compost. Currently, many farmers in Bangladesh are using Tricho-compost to increase soil fertility and to get higher crop yield. A study was conducted with the purpose of determining: (i) the farmer's livelihood improvement as a result of tricho-compost application in soil, (ii) the personal and socio-economic characteristics of the farmers', and (iii) the contribution of socio-economic characteristics of farmers' to their livelihood status. For the qualitative experiment, the rural farmers involved in tricho-composting were the population under the study. A total of 20 locations were purposively selected from 120 locations and 10 respondents from each of the location were randomly selected to make a sample size of 200. Livelihood status of the farmers

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was the dependent variable while personal and socio-economic characteristics of the farmers were the independent variables which included age, education, family size, farm size, annual income, extension media contact, cosmopoliteness, agricultural knowledge, innovativeness, housing condition, sanitation, livestock possession, household asset, receipt of loan and environmental awareness. These characteristics were measured using standard statistical scoring techniques. The regression coefficient of eight variables namely education, annual income, extension media contact, cosmopoliteness, agricultural knowledge, livestock possession, household assets and environmental awareness were statistically significant indicating that these variables had a significant contribution to the livelihood status of *Trichoderma* practicing farmers. The other seven variables had no significant contribution to the livelihoods of farmers**.** Tricho-composting has a lot of contribution in changing the livelihoods of the farmers.

Keywords: Trichoderma; compost; livelihood.

1. INTRODUCTION

1.1 Background of the Study

Bangladesh is a country with populations of approximately 163 millions and continues to increase at a galloping rate. The demand for food is also increasing [1]. But the fertility of soil is visibly declining alarmingly [2]. To guarantee food for all, either the population growth has to be checked or production of food is to be increased and for this reason the fertility of soil must naturally be increased. The country has been producing sizeable quantity of crops and cereals and this achievement has been made possible due to the use of high doses of synthetic fertilizers and improved varieties of seeds.

Today, farmers have to ponder over the matter of increasing crop production because the output of crop productivity is only high when soil contains reasonable organic matter. The organic matter (OM) status of Bangladesh soil is one of the lowest in the world. The average OM content of Bangladesh soils is less than 1%, ranging between 0.05 and 0.9% in most cases affecting the government endeavors to ensure national food security. The ratio of organic matters in soil has decreased to even 0.6% in some places over the past 5-6 decades [3].

Low organic matter supply in soil is one of the major constraints in agricultural productivity of the country. The organic matter in the soil can be increased by application of organic fertilizer which contain living cell of different microorganisms, can prevent the depletion of the organic matter [4]. It has also been observed that the application of organic fertilizers increases yield and reduce environmental pollution [5]. In such a context, there is an urgent need for motivating farmers to use organic fertilizer more to improve soil fertility so that they will be able to harvest benefit of accelerated production in the long run.

Trichoderma itself is a compost fungus and effective activator for rapid composting. It is an environment friendly soil borne fungus that speeds up decomposition of organic materials. It enhances the decomposition of organic materials within 4-5 weeks whereas the traditional method takes 3-4 months [5]. The Tricho-compost significantly increases soil fertility and fetches higher crop yield. It also acts as bio-pesticides. It is well documented that the interaction of *Trichoderma* strains of Tricho-compost with the plant may promote increase of growth nutrient availability and enhances power of disease resistance [5].

Decomposition of organic matter in association with *Trichoderma* compost is used to increase soil health which ultimately increases production of crops in the field. This may eventually improve the level of livelihood status of a person. This good practice option was tested in this research through the active participation and involvement of local farmers and end-users. The research identified rapid composting using *Trichoderma* as a location-specific and appropriate option for livelihood improvement. Necessary information is needed by the farmers regarding tricho-compost [6].

Many farmers are already practicing this and securing disease-free crop and it is used effectively at the household level for better yield. The Rural Development Academy, Bogura, is producing *Trichoderma* enhanced composting technology using cowdung and household waste. It makes a great contribution towards development of safe environment and nutrient

enriched fertilizer, a good element for improving soil health. It is very important to look at the performance of such compost on soil health and farmer's livelihoods. There are very few research has been found regarding the livelihood improvement through *Trichoderma* application in soil. So it is very important to determine the extent of livelihood improvement.

1.2 Research Questions

Under the above discussion, the study was undertaken to answer the following research questions:

1) How farmer's livelihoods were improved through application of *Trichoderma* on soil?
2) What were the personal and socio-economic characteristics of the farmers?
3) What were the contributions of socio-economic characteristics of farmer to their livelihood status?

In order to answer the above research questions the following research objectives were undertaken to guide the research in a meaningful way.

1.3 Research Objectives

This research is proposed to fulfill the following objectives:

1) To assess the farmer's livelihood as a result of tricho-compost application on soil.
2) To determine and describe the personal and socio-economic characteristics of the farmers.
3) To examine the contribution of socio-economic characteristics of farmer to their livelihood status.

2. METHODOLOGY

2.1 Locale of the Study

The research was conducted at five different districts of Bangladesh i.e., Bogura, Joypurhat, Sirajgonj, Gaibandha and Naogaon because the rural farmers of these areas are involved in using *Trichoderma* in their soil to improve crop production as well as their livelihood.

2.2 Population and Sampling of the Study

From the selected five districts of Bangladesh 120 study spots were selected as the location of research where *Trichoderma* enhanced composting technology had been in field operation and being practiced by the rural farmer. A total of 20 locations were purposively selected from 120 locations and 10 farmer from each of the locations were randomly selected to make the respondents number 200. These 200 *Trichoderma* enhanced composting technology practicing farmers were the sample size of the study.

2.3 Study of Baseline Survey

A baseline survey was conducted regarding the socio-economic characteristics of the farmer involved with *Trichoderma* enhanced composting technology.

2.4 Preparation and Application of *Trichoderma* to Farmer's Field

2.4.1 Treatment, replication and experimental layout

For the experiment, 6 substratum e.g., water hyacinth, rice stubbles, potato plant, cowdung, household waste and bio-slurry was used for decomposition and mixed with *Trichoderma* suspension in each pit. These six substratums were mixed with 5 doses of *Trichoderma* suspension at 0, 250, 500, 750 and 1000 ml per pit. These treatments were replicated thrice thus a total of 90 pits were prepared to conduct the experiment.

2.4.2 Pit preparation and filling with substratum

The pit size was 45 inch in length, 45 inch in width and 20 inch depth which was filled with six different substratums as stated above. Each of the substratums was well mixed with cowdung and first 06 inches layer of the pit was filled and sprayed with *Trichoderma* suspension followed by two other layers prepared the same way. The remaining 2 inches was filled with the substrates and the pit was covered with polythene sheet and left for a week. After a week, the whole materials were mixed well in order to make a uniform decomposition and water was added if the substratum found dry and kept covered with

polythene sheet. After 5 weeks, the compost is ready for field application.

2.4.3 Field application

After preparation of tricho-compost, it was applied to the field to grow boro rice and the yield potentials of the compost were determined through soil analysis by comparing with control plots. The yield differences were also considered to measure the changes in livelihood status of farmer.

2.5 Determination of Livelihood Status of Farmer

The livelihood of rural farmer in the present study was ascertained by asking them on 25 livelihood-related statements that associates with human, natural, physical, social and financial capital. Each of the statements were measured with 03 (three) point rating scale as 'increased', 'same as before' and 'decreased' and a corresponding score of 3, 2 and 1 was given respectively. Therefore, the range of score could vary between 25 to 75, where 25 indicating livelihood status decreased at the lowest level and 75 for livelihood improved at the highest level.

2.6 Measurement of the Socio-economic Characteristics

The personal and socio-economic characteristics of the famers were the independent variables which included age, education, family size, farm size, annual income, extension media contact, cosmopoliteness, agricultural knowledge, innovativeness, housing condition, sanitation, livestock possession, household asset, receipt of loan and environmental awareness which were measured by using standard scoring techniques.

2.7 Data Gathering Instruments

A set of data gathering instruments was prepared for data collection. In order to make the instrument valid and reliable, it was tested through judge rating. After piloting the instrument, the final version of the instrument was prepared and used in data collection.

2.8 Data Collection

Data were collected through face to face interview using a structured interview schedule by researcher himself. In addition, study of available records and observation of group activities was recorded. Data were also collected from field and laboratory experimentations.

2.9 Statistical Analysis

The data were coded, compiled and tabulated in accordance with the objectives of the study. Various statistical measures such as number and percentage distribution, range, mean and standard deviation were used in describing the variables. To find out relationships among the variables, Pearson's Product Moment Correlation Coefficients (r) were computed. Stepwise multiple regression analysis was conducted to determine the explanation of total variation of a given variable based on one or more variables. Paired t-test was computed to determine the significant differences between the baseline situation and situation after intervention of *Trichoderma* application among the farmers. Data were analyzed through statistical package for social sciences (SPSS) software.

3. RESULTS AND DISCUSSION

For convenience of the discussions the findings are systematically presented as follows: Livelihood status based on five components, personal profile of the farmers, relationship between personal profile of the farmers and their livelihood status and contribution of personal profile of the farmers to their 'livelihood status.

3.1 Livelihood Status Based on Five Components

This section deals with the livelihood status of farmers in each of the five components viz. human capital, natural capital, physical capital, social capital and financial capital.

3.1.1 Human capital

A total of 5 aspects were included to determine the human capital status of farmers. The respondents were asked to indicate if any changes occurred in each of the 5 selected aspects as a result of their use of *Trichoderma* composting technology during the last three years along a three point rating scale as "increased", "remained same" and "decreased". Fig. 1 contains the findings regarding human capital.

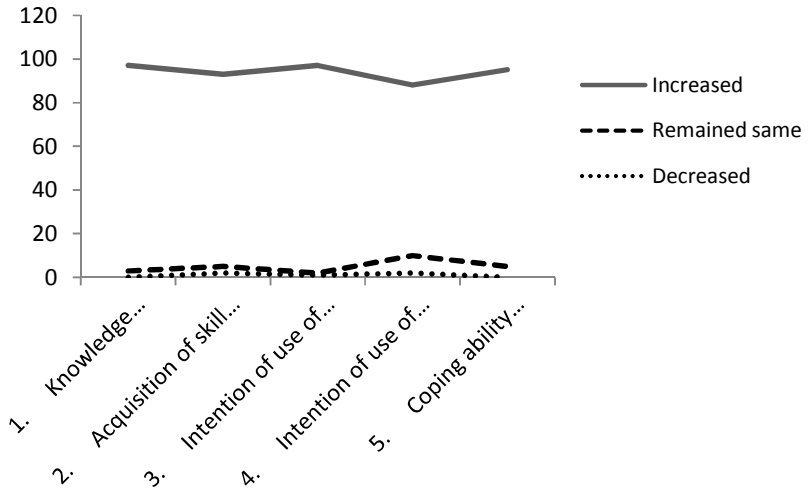

Fig. 1. Percentage distribution of farmers according to their status of human capital

In all aspects of human capital, there has been a positive change as expressed by the farmers. It seems like the *Trichoderma* composting technology is a good practice for increasing soil health and productivity which in turn reduce the hazard of chemical fertilizer. Farmers also expressed their positive opinion regarding the increase of coping capability towards reduction of crop loss due to adverse circumstances which may have some linkage with use of *Trichoderma* in their field.

3.1.2 Natural capital

A total of 5 aspects were included to determine the natural capital status of farmers. The respondents were asked to indicate if any changes occurred in each of the 5 selected aspects as a result of their use of *Trichoderma* composting technology during the last three years along a three point rating scale as "increased", "remained same" and "decreased". Fig. 2 contains the findings in these respects.

The natural capital resource base was organized based on the interaction between soil fertility and productivity as a result of outcome of *Trichoderma* use. From that view point, data presented in Fig. 2 indicate that, majority of the farmers expressed their opinion in favor of increased the natural capital over the years except presence of earthworm in soil. Data in the Figure expressed the view that use of *Trichoderma* in soil increased the soil properties which is helpful for crop production.

3.1.3 Physical capital

A total of 5 aspects were included to determine the physical capital status of farmers. The respondents were asked to indicate if any changes occurred in each of the 5 selected aspects as a result of their use of *Trichoderma* composting technology during the last three years along a three point scale: "increased", "remained same" and "decreased". Fig. 3 contains the findings in these respects.

Data presented in Fig. 3 indicated that almost all cases of physical capital significantly increased except the number of agricultural implements in farmer's possession. Poultry birds and ducks are one of the major income generating items for rural women – which have increased to a significant level. Overall conditions of physical capital were found to be satisfactory.

3.1.4 Social capital

A total of 5 aspects were included to determine the social capital status of farmers. The respondents were asked to indicate if any changes occurred in each of the 5 selected aspects as a result of their use of *Trichoderma* composting technology during the last three years along a three point scale: "increased", "remained same" and "decreased". Fig. 4 contains the findings in these respects.

Data reflected in Fig. 4 indicate that majority (83.5%) of the farmers are of the opinion 'increased' for the social capital aspect of

communication with agriculture department personnel while nearly three-quarter (78%) of the farmers opined on coping capabilities towards physical assault due to theft, robbery etc. However, social security was found to have been increased as expressed by 72% of the farmers and an overwhelming majority (90.5%) of the farmers said the exchange of views and ideas among the farmers were found to have been increased whereas only about half (53%) of the farmers expressed that establishment of farmers cooperatives were increased over the years. The overall performance of the social capital in respect of using *Trichoderma* composting technology by the farmers was found increased to a significant level.

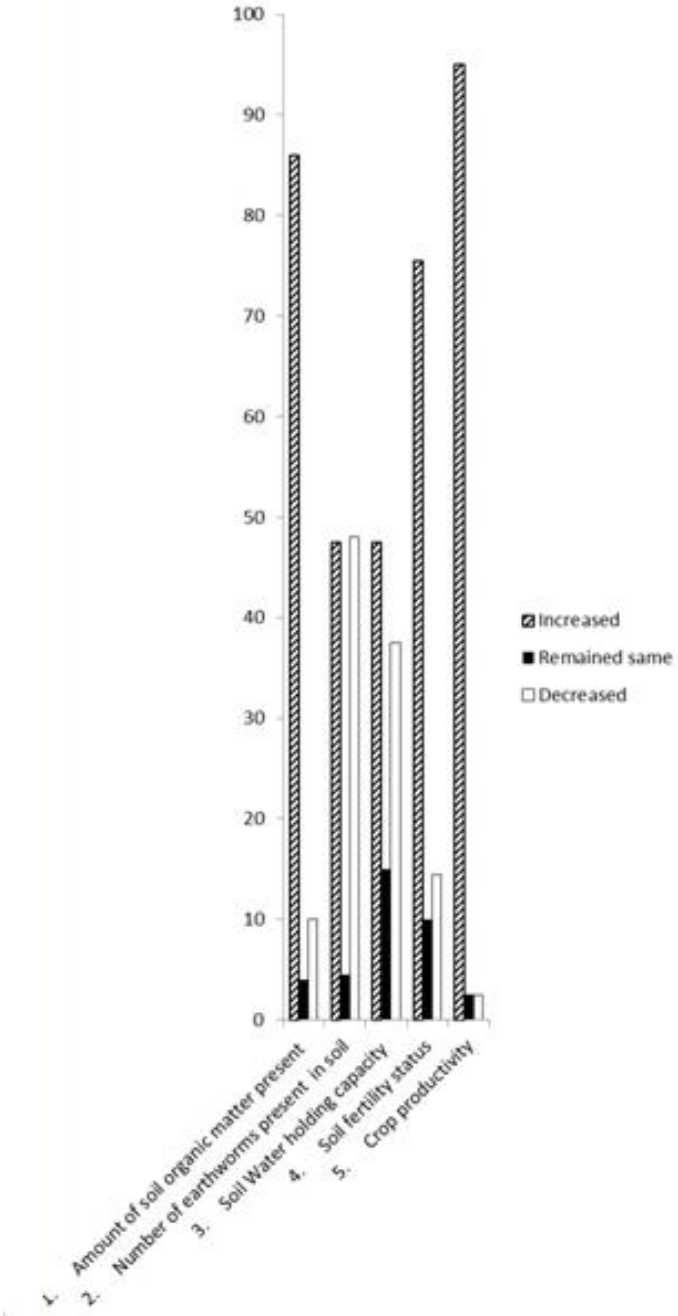

Fig. 2. Percentage distribution of farmers according to their status of natural capital

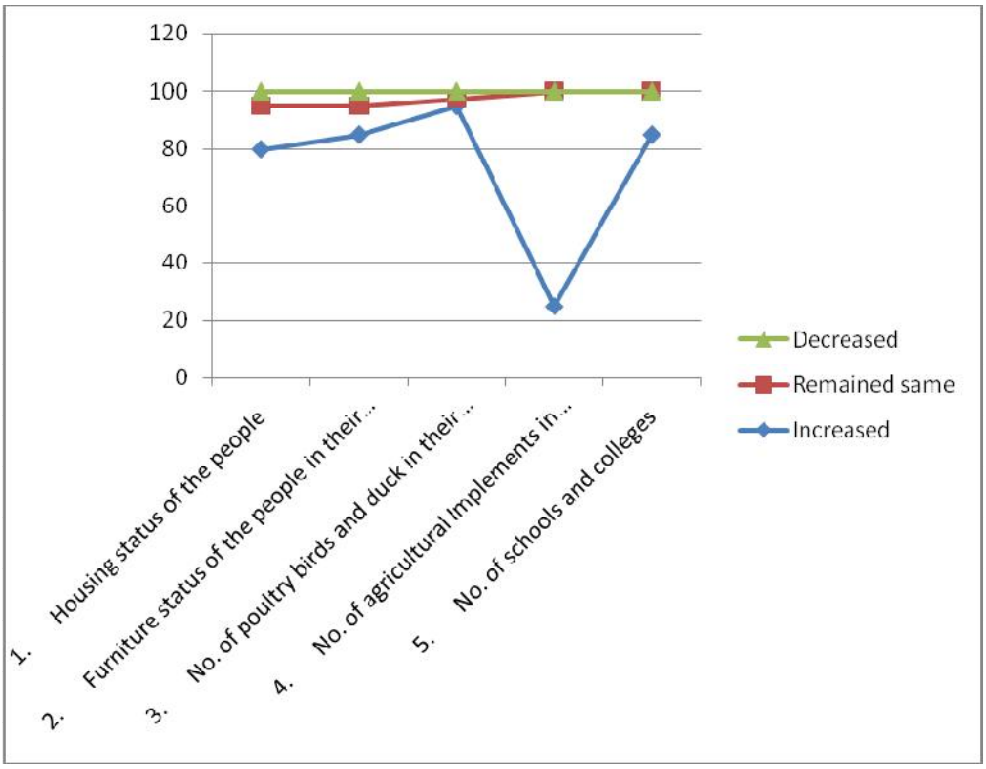

Fig. 3. Percentage distribution of farmers according to their status of physical capital

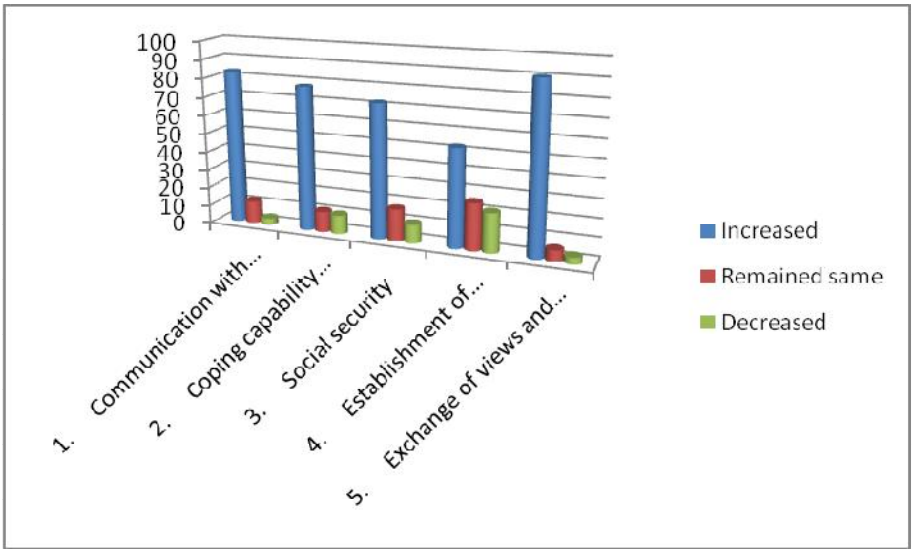

Fig. 4. Percentage distribution of farmers according to their status of social capital

3.1.5 Financial capital

A total of 5 aspects were furnished to determine the financial and results. An overwhelming majority (97%) of farmers expressed that loan availability was increased. It was due to NGO activities which ultimately decreases the loan taking from money lenders.

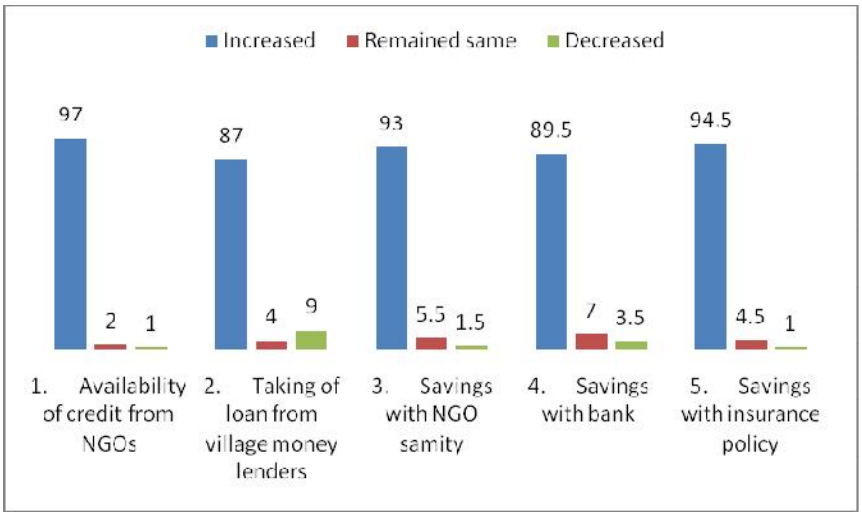

Fig. 5. Percentage distribution of farmers according to their status of financial capital

Data revealed from Fig. 5 that majority (93%) of the farmers were able to increase their savings with NGOs, at the same time majority (89%) of them opined that savings increased with bank and insurance policy (94.5%). From the findings it could be concluded that, financial capital of the farmers were found to be increased to a significant level.

3.1.6 Overall livelihood status of farmers

Livelihood status of farmers was determined by selecting items which related to each of the five components of livelihood: human capital, natural capital, physical capital, social capital and financial capital. A total of 25 items were selected taking 5 items each from 5 capitals were put against a 3 point rating scale e.g., 'increased', 'remained same' and 'decreased' in comparison to situation prevailed before a year to two and score given as 3,2, and 1, respectively. Therefore, the range of score could vary from 25 to 75, where 25 indicates lowest level of livelihood status and 75 indicating the status of livelihood of the farmers at the highest level. Based on livelihood status category the farmers were classified into three categories as 'low status', 'medium status' and 'high status. The distributions of the farmers have been presented in Fig. 6.

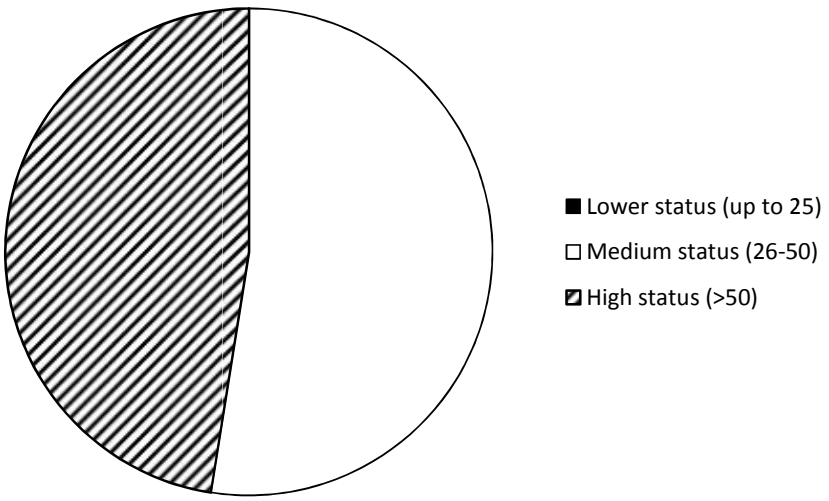

Fig. 6. Distribution of the respondents according to their livelihood status

Slightly more than half (52.5%) of all farmers were found under 'medium status' category compared to less than half (47.5%) of them under 'high status' category. None of the farmers were found to have 'low statuses' category. Islam [7] found that two-third majority of the farmers were found to have medium status and nearly one-sixth of them fell under high and low status of livelihoods. If we look at the comparative picture among the five livelihood components it seems that human and financial capital of the farmers was found to have been drastically increased which might have played a vital role to express a positive statement towards increment of other components that suppressed the opinion regarding lower status of livelihoods of the farmers.

3.2 Personal Characteristics of the Farmers

This section deals with the presentation of findings of 15 selected personal and socio-economic characteristics of the farmers. The findings are presented in terms of number and percentage below.

3.2.1 Age

The age of the farmers ranged from 21 to 65 with a mean and standard deviation of 45.51 and 13.16, respectively. Slightly more than two-fifths (42.0%) of the farmers were old (above 50 years) while a little less than one-third (31.5%) of them were under middle aged (36-50) and 26.5% of them were young (18-35 years).

3.2.2 Education

Education of the respondents was found to range from illiterate to tertiary level graduates. The highest proportion (37.5%) of the respondents had higher secondary level of education followed by 28.0% having primary level education, 13.5% of the respondents had graduation level, 12.5% had secondary education and only 8.5% of them were found to be illiterate. Muttaleb [8] and Akter [9] also reported similar findings on farmers' educational status in their studies.

3.2.3 Family size

Family size of the respondents ranged from 2 to 13 members with an average of 4.95 with a standard deviation of 2.07. 9. Majority (56.5%) of the respondents had small family compared to nearly one-third (31.5%) of the respondents had medium family size and only 12.0% of them had large family size. The finding corroborates the findings of several researches [9,10,11].

3.2.4 Farm size

Farm size of the respondents was found to range from 0.06 to 4.74 ha, the average being 0.82 ha with a standard deviation of 0.70 ha. Based on their farm size score, the respondents were categorised as follows.

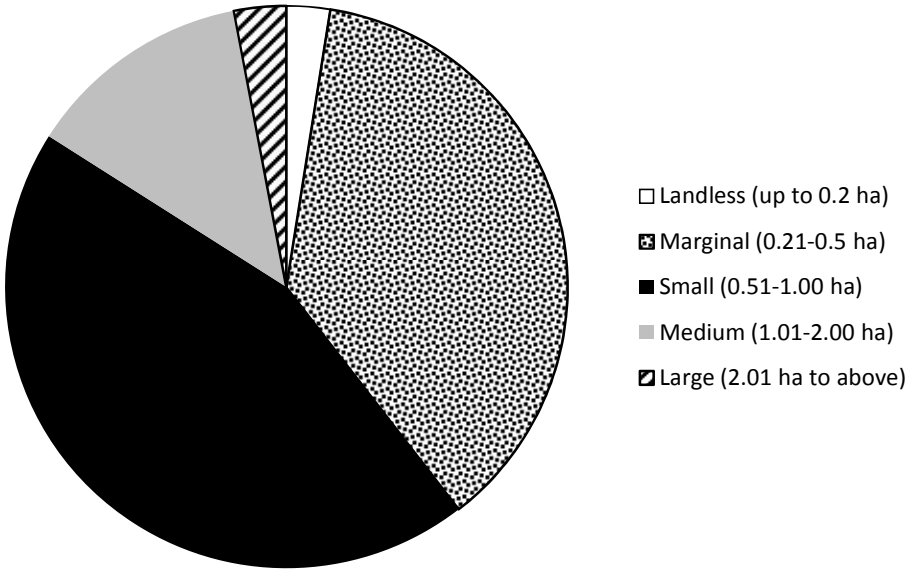

Fig. 7. Percentage distribution of the respondents according to farm size

Large farm size is the indicator of more farm operations. Big farmers are supposed to be more aware of different technologies. It develops their abilities to analyse facts and situations to take correct decisions on farm production.

3.2.5 Annual income

Annual income of the respondent was found to range from 15 thousand taka to 998 thousand taka with a mean of 151.88 thousand taka, standard deviation of 137.50. The majority of farmers (53.5%0 had a medium income (The with low oincome farmers making 33% of the sampled farmers and 13.5% high income. Higher annual income of the farmers allows them to invest more capital in farming operations which ultimately lead them to come in contact with various information sources. Therefore, more contact with information sources motivates them to practice improved farming activities for maintaining financial superiority in the society [12].

3.2.6 Extension media contact

Extension media contact scores of the respondents ranged from 0 to 16. Most farmers had medium (51.5%) and low (42.5%) exposure to extension media. Only 1% had no exposure to extension media while 5% had high exposure. [10,13] found the similar findings in their respective studies.

3.2.7 Cosmopoliteness

The cosmopoliteness scores of the respondents ranged from 0 to 23 with a mean and standard deviation of 7.37 and 4.36, respectively. Majority (74.5%) of the respondents were having medium cosmopoliteness and one-fourth of them (24.0%) had low cosmopoliteness and very negligible proportion of them (1.0 and 0.5%) were having high and low cosmopoliteness, respectively. The findings had similarity with the findings of Hamidi [14], and Haque [15].

3.2.8 Agricultural knowledge

The agricultural knowledge scores of the respondents ranged from 6 to 20 against the possible range of 0 to 20 with a mean and standard deviation of 15.12 and 3.45, respectively.

Two-thirds of the respondents had high agricultural knowledge and one-third of them had medium knowledge, only a very negligible proportion of them (0.5%) had low knowledge.

3.2.9 Innovativeness

The innovativeness scores of the respondents ranged from 0 to 33 with a mean and standard deviation of 11.69 and 6.25, respectively. Nearly two-third majority (64%) of the respondents did not receive any credit from any sources, however, slight more than one-fourth (28.5%) of the respondents were found to be low receiver of credit, only 6.0% of them were medium receiver and very negligible proportion of them were found to have received credit to a higher extent.

3.2.10 Housing condition

The housing condition scores of the respondents ranged from 3 to 60 with a mean and standard deviation of 15.36 and 9.41, respectively. More than two-third majority (68%) of the respondents were found to have low housing condition and slight more than one-fourth (27.5%) of them had medium possession and only 4.5% of the respondents had high housing condition.

3.2.11 Sanitation facilities

The sanitation facilities scores of the respondents ranged from 2 to 9 with a mean and standard deviation of 7.24 and 1.55, respectively. More than two-third majority (70%) of the respondents was found to have low sanitation and more than one-fourth (29.5%) of them had medium sanitation and very negligible proportion (1%) of the respondents had high sanitation facilities.

3.2.12 Possession of livestock

The livestock possession scores of the respondents ranged from 0 to 46 with a mean and standard deviation of 9.44 and 8.17, respectively. Almost two-third majority (65.0%) of the respondents had low possession of livestock followed by one-fifth (20.0%) of them had medium possession and only few (2.5%) of them had high possession of livestock.

3.2.13 Environmental awareness

The environmental awareness scores of the respondents ranged from 14 to 34 against the possible score of 10 to 40, with a mean and standard deviation of 26.69 and 3.59, respectively. An overwhelming majority of the

respondent (93.5%) were found to have high environmental awareness compared to only 6.5% of them had medium awareness.

3.2.14 Asset endowment

The asset endowment scores of the respondents ranged from 3 to 50, with a mean and standard deviation of 29.55 and 12.37, respectively. More than half of the respondent (55.5%) were found to have high asset endowment compared to more than one-third (37.5%) of them had medium asset endowment.

3.3 Contribution of the Personal Profile of the Farmers' to Their Livelihood Status

The results of correlation analysis are as shown in Table 1.

Out of 15 variables, the correlation coefficient of 13 variables was significant. These were age, education, family size, farm size, annual income, extension media contact, cosmopoliteness, agricultural knowledge, innovativeness, housing condition, sanitation, household assets and environmental awareness. Secondly regression analysis was run to determine the factors that explain the variation in the 'livelihood status' of farmers.

The coefficient of correlation indicates the linear relationship between the two variables. It does not say anything about the contribution of a particular independent variable on the dependent variables. Therefore, linear multiple regression analysis was done to determine the contribution of various characteristics of farmers to their 'livelihood status'. Only those variables which had significant relationship with 'livelihood status' of the farmers were included in the regression analysis model. Thus, a total of 13 variables namely, age, education, family size, farm size, annual income, extension media contact, cosmopoliteness, agricultural knowledge, innovativeness, housing condition, sanitation, household assets and environmental awareness had a significant relationship with 'livelihood status' of the farmers were used in the model. The findings of the regression analysis are presented in Table 2.

The regression coefficient of only 8 variables namely education, annual income, extension media contact, cosmopoliteness, agricultural knowledge, housing condition, household assets and environmental awareness were statistically significant indicating that these variables had a significant contribution to the 'livelihood status' of *Trichoderma* practicing farmers. The other five variables had no significant contribution to the same.

3.4 Changes in Socio-economic Characteristics of the Farmers

The impact assessment of personal and socio-economic characteristics of the respondents was determined by means of analyzing between before and after intervention data and put into Table 3.

Table 1. Relationship between livelihood status and selected characteristics of the farmers

Selected characteristics of respondent	Correlation coefficient (r)
Age	-0.149*
Education	0.602**
Family size	0.167*
Farm size	0.399**
Annual income	0.385**
Extension media contact	0.597**
Cosmopoliteness	0.544**
Agricultural knowledge	0.338**
Innovativeness	0.314**
Housing condition	0.194**
Sanitation	0.239**
Livestock possession	0.051^{NS}
Household assets	0.346**
Receipt of credit	-0.032^{NS}
Environmental awareness	0.301**

*** Significant at the 0.01 level; * Significant at the 0.05 level; NS = Not significant*

Table 2. Regression coefficient of livelihood status of the farmers with their selected characteristics

Characteristics of *Trichoderma* practicing farmers	Regression coefficient		Significant level
	Unstandardised coefficient	Standardised coefficient (Beta)	
Constant	32.566		0.000
Age	-0.009	-0.044	0.378
Education	1.285	0.617***	0.000
Family size	0.347	0.076	0.159
Farm size	1.550	0.110	0.082
Annual income	0.014	0.206**	0.001
Extension media contact	0.685	0.242***	0.000
Cosmopoliteness	0.482	0.212**	0.001
Agricultural knowledge	0.228	0.374**	0.003
Innovativeness	0.116	0.073	0.208
Housing condition	0.118	0.115*	0.043
Sanitation	-0.205	-0.032	0.559
Household assets	0.100	0.129*	0.048
Environmental awareness	0.294	0.111*	0.038
R^2 = 0.602, F value = 18.553, P = 0.00			

*** P< 0.001 level; ** P< 0.01 level; *P<0.05 level*

Table 3. Status of socio-economic characteristics of the farmers after application of tricho-compost

Personal profile of the farmers	Mean score		t-value	df	Significance level
	After	Before			
Age	46.72	45.51	0.032	199	0.243
Education	5.88	5.82	0.629	199	0.530
Family size	4.70	4.95	1.975	199	0.435
Farmsize	186.09	203	1.037	199	0.301
Annual income	168641	137954	5.835*	199	0.031
Extension Media Contact	6.60	6.08	2.379*	199	0.018
Cosmopoliteness	6.69	7.37	2.591**	199	0.010
Agri-knowledge	17.31	15.12	10.708***	199	0.000
Innovativeness	11.54	11.69	0.355	199	0.723
Material possession	18.66	15.36	4.368***	199	0.000
Sanitation	7.87	6.24	2.834**	199	0.005
Livestock possession	11.18	9.44	3.321**	199	0.001
Household asset	36.52	32.18	4.628**	199	0.003
Loan	15096.00	19452.00	1.632	199	0.104
Environmental awareness	28.67	26.69	9.546***	199	0.000
Livelihood status	64.20	60.23	6.763***	199	0.000

*** P< 0.001 level; ** P< 0.01 level; *P<0.05 level*

Livelihood status of a person is sum totality of his/her standing against five livelihood capitals–viz. human capital, natural capital, physical capital, social capital and financial capital which was tested against the null hypothesis as there is no significant difference in livelihood status between before and after intervention. The mean score of environmental awareness after the intervention was found 64.20 against the mean score of the same for before intervention was 60.23. The mean difference was statistically significant and therefore, the null hypothesis was rejected and the researcher concluded that, there is increase of livelihood status has taken place which was found statistically significant. Similar results also found by Hanif [16]. From this finding it may also be concluded that, after application of tricho-compost in the farmers' field, the level of

livelihood status has been increased which was found significant.

4. CONCLUSIONS

On the basis of findings, discussion and interpretation the following conclusions were made.

1. Human capital is one of the basic and fundamental components of livelihood asset pentagon which was found increased to a significant level. Almost all items of this capital were increased as stated by more than 90% of the respondents.
2. Natural capitals like the amount of organic matter presence of soil, soil fertility status and crop productivity status in the land were increased as stated by an overwhelming majority of the respondents. This is also a very positive indicator for intervention like *Trichoderma* enhanced composting technology applied in the farmer's field.
3. After application of tricho-compost the aspects of social capital was found increased as stated by 83.5% of the respondents followed by coping ability towards physical assault with theft, robbery by 78%, increase of social security by 72.5% and exchange of views and ideas among the farmers by 90.5%. Only establishment of farmers cooperatives as stated by 53%. From this findings it could be concluded that, for better communication and increase of strength, making a common platform is necessary. Therefore, establishing farmers' cooperative is a vital aspect which found lacks and need attention make it in future.
4. Using tricho-compost helped a lot for improving financial capital of the farmers.

5. RECOMMENDATIONS FOR POLICY IMPLICATION

Based on experience, observation and conclusion drawn from the findings, the following recommendations are made to the concerned authority, planners and executioners.

1. Education was found to have a strong linkage with livelihood status and there are significant proportion of the respondents in the study area were found illiterate. In order to improve their livelihood status, the improvement in the education status is necessary.
2. Annual income was found to have linear relationship with housing condition, sanitation status and household asset meaning that a person having higher income status used to have better housing condition, owning good sanitation status and improved household assets. There are numerous ways to increase annual income. Adoption of improved agricultural technologies are supposed to increase farmers' annual income where tricho-compost could play an important role. Necessary motivation campaign should therefore is necessary to start for increasing annual income of the farmers.

6. RECOMMENDATIONS FOR FURTHER STUDY

1. The present study was conducted in the northern part of the country. Similar study should be undertaken to find improvement in livelihood status in other part of the country.
2. The research only confined *Trichoderma* compost there are other agricultural technologies which may have similar impact on farmers production potentials of their crops in the field for better livelihoods.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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