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Rice crop residue management and its impact on farmers livelihood - an empirical study

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Abstract

The study aimed to examine the present status of rice crop residue management and its impact on farmers' livelihood covering two sub-districts in Mymensingh district of Bangladesh. A total of 100 farmers (50 for crop residue practicing farmers and 50 for the farmers involved in traditional farming) were selected randomly for data collection. A combination of descriptive, statistical and mathematical techniques were applied to achieve the objectives and to get the meaningful results. The results of descriptive statistics showed that retention was found higher in far distance plots from homestead. No retention of crop residues was found in case of Aus and Aman rice. The whole retention was found only in case of *Boro* rice. The shortage of labour in season and the wage rate were also important factors for the retention of crop residues. However, farmers' perceptions about the use of crop residues were mostly adding organic matter to the crop field followed by mulching and feeding animal. The recycling of resources among crop retention and livestock has the great potential to return a considerable amount of plant nutrients to the soil in the rice based crop production systems. Due to crop residue practices, crop and livestock both were benefited through resource interdependences. The sampled farmers were benefited from retention of crop residues by improving soil quality, soil moisture, etc.; and farmers used less amounts of fertilizer, irrigation water, etc. for the succeeding crops. Consequently, succeeding crop productivity, profitability and annual income were increased significantly. The result of logit regression model shows that age of household head, farm size, agricultural income and non-farm income were found as significant variables in explaining the variation in crop residue adoption of farm households. To assess the livelihood pattern of sample farm households through asset pentagon approach, noteworthy improvement was found s on different capitals. The study identified some problems regarding crop residue management and finally, recommended that if the farmers get proper training for such management, it would be helpful to improve their livelihood.

Key words: Crop residue, asset pentagon approach, farmers livelihood

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Introduction

In Bangladesh, rice is the most important crop from the perspective of production volume, value, land coverage and employment generation (BBS, 2011). Rice based cropping patterns are the most intensive production system in the country. Rice-rice-wheat, jute-rice-rice, rice-rice or rice-wheat are the most intensive cropping patterns. But the conventional agricultural production practices are comparatively lower-yielding and it seems difficult to change this yield with reachable resources under the prevailing situation. Due to growing repeated cereal crops, soil fertility and crop productivity are reducing over the time. This has occurred through inappropriate management of fertilizers, tillage and crop residues (Singh and Singh, 2001).

Crop residues are the materials left in an agricultural field after the crop harvested. These residues include stalks, stems, leaves and seed pods. Normally, these are either harvested as fuel, animal bedding or are burnt in the field. As harvest remnants, crop residues play an essential role in nutrient recycling to improve soil quality and ensure higher level of crop productivity. It can be composted by various methods on the farm and used in the field for mulching. Incorporation of crop residues in the field alters the soil environment, which in turn influences the microbial population and activity in soil and subsequent nutrient transformations. The recycling of crop residues has great potential to return a considerable amount of plant nutrients to the soil. Left on the soil surface, crop residue serves as a mulch to decrease soil temperature and maintain higher soil moisture as well as reduce carbon emission in the atmosphere. Crop residue practice is suggested for the purpose of preserving and enhancing productivity (Wilhelm *et al.* 2004). It results in substantial saving in irrigation water and fertilizer and thereby improves soil fertility and enhances crop productivity. In addition, these can be used as animal fodder. The collected residue can be composted by using it as animal bedding and then heaping it in dung heaves. It aims to help farmers to earn more income with reduced amount of labour, fertilizer, irrigation and other input costs. However, it is a great challenge for the agriculturists to manage rice residues effectively and efficiently in order to enhance crop production.

A few studies concerning specific aspect of crop residue have been performed by different researchers. Tanvir *et al*. (2013) examined farmers' choices for rice residue burning in Pakistan and found that an increase in the burning of rice residue after the entry of the combine harvester; Akteruzzaman *et al.* (2012) conducted study on utilization pattern of crop residue at farm level for diversified rice-based cropping systems in Bangladesh; Arshadullah *et al.* (2012) analyzed the effect of wheat residue incorporation along with starter dose on rice yield and soil health under saline sodic soil; Ogbodo (2010) assessed the effect of crop residue on soil physical properties and rice yield on an acid ultisol in Nigeria; Maung (2008) performed a case study on economics of biomass fuels for electricity production with crop residue and found that crop residue currently costs much more than coal for electricity generation; Powlson *et al.* (2008) conducted a study on carbon sequestration in European soils through straw incorporation and found that greater savings in carbon emissions and climate change mitigation can be obtained by removing the straw and using it for energy generation; Sharma and Prasad (2008) conducted a study on coupling of green manuring with residue incorporation for increased and sustained grain productivity; Sidhu *et al.* (2008) did a case study on rice residue management and found that incorporation of crop residues of both crops in the rice-wheat cropping system has increased the soil organic and total nitrogen contents; Badarinath *et al.* (2006) studied agricultural crop residue burning in the Indo-Gangetic plains using satellite data and demonstrated that residue incorporation leads to a sustained and improved crop yield; Eagle *et al.* (2000) examined nitrogen dynamics and fertilizer use efficiency in rice following straw incorporation and winter flooding and found that field incorporation of residue is more advantageous and beneficial than field burning or removal.

The above literature review indicates that most of the studies attempted impact assessment of crop residues on soil health and crop yield. Such analyses, in addition to being very partial in nature, address the utilization of the available resources mainly in physical/technical terms. Therefore, much work is required to enhance the empirical knowledge regarding present status of rice crop residue practices and its impact on farmers' livelihood in order to formulate policy options. However, the present study will provide an insight to the farmers for making decisions either they should follow crop residue practices or still follow the alternative practices of farming. With that view, the specific objectives set for the study are as follows: (i) to evaluate farmers' perceptions for the use of rice crop residue with resource recycling between crop and livestock components; (ii) to assess the impact of crop residue practice on the succeeding crop productivity and profitability; (iii) to assess the impacts of rice crop residues on farmers' income generation and livelihood pattern; and (iv) to determine the factors responsible for the adoption of rice crop residue practices by the farmers.

Materials and Methods

The study was conducted at different villages of two sub-districts (i.e., Mymensingh Sadar and Gouripur) of Mymensingh District where farmers have been following crop residue practices. Focus group discussions (FGD), Field surveys and key informant interviews (KII) were followed to collect primary data and information for one year (i.e., 2013) farming operations. A total of 100 (50 from each sub-district) farmers was interviewed for this study. Data were collected from respondents using structured questionnaire. Secondary data and information from different reports, publications, notifications, etc. relevant to this study were also collected and analyzed for this research. Two sets of questionnaire were developed, one for farmers who are following crop residue practice and the other one for the farm households involved in traditional practices. A combination of descriptive, statistical and mathematical techniques was applied to achieve the objectives and to get the meaningful result. Descriptive statistics (i.e., sum, average, percentages, ratios, standard errors, etc.) in support of flowcharts and figures were used.

Productivity measurement

Productivity was measured as the ratio of farm's total outputs to its inputs (Huq *et al.*, 1990). Here, both physical amount and monetary value have been used to measure productivity of different enterprises.

Profitability analysis

It is important to consider the economic value of the crop in analyzing the profitability of crop. Per hector profitability of crop production from the view point of individual farmers was measured in terms of gross return, gross margin, net return and benefit cost ratio (undiscounted). As a thumb rule, an enterprise with higher or positive gross margin is deemed viable. Hence, gross margin analysis was used to assess the profitability of crop production.

According to Barnard and Nix (1999), gross margin (GM) of farming enterprise is its output less the variable costs attributed to it. However, this study employs the definition preferred by Visagic and Ghebretsadik (2005) that sees gross margin as the difference between the gross incomes derived from each enterprise minus the total variable costs (TVC). In crop production, the variable cost consists primarily of expenses on seed, family labour, hired labour, fertilizer, manure etc. These are aggregated to obtain the total variable costs. The enterprise output is the total value of the production of the enterprise.

Computation of gross return

Gross return was calculated by multiplying the total volume of production of an enterprise by the average prices (the average of the farm gate price) of that product in the harvesting period (Dillon and Hardaker, 1993). The following equation was used to estimate gross return (GR):

$$GR = \sum_{i=1}^{n} Q_i P_i$$

Where,

GR_i = Gross return from i^{th} product (Tk./hectare)

Q_i = Quantity of the i^{th} product (Tk./hectare)

P_i = Average price of the i^{th} product (Tk./kg);

and i = 1,2,3………… n.

Computation of total cost

Total cost (TC) includes all types of variable and fixed cost items involved in the production process. The total cost was estimated as follows;

$$TC = \sum P_x \times X_i \times A + TFC$$

Where,

TC = Total cost (Tk./hectare); Xi = Quantity of input (kg/ hectare);

A = Area under crop production measured in hectare;

P_{xi} =Per unit price of the i^{th} product (Tk./kg); and

TFC = Total fixed cost includes cost of tools and equipment, land use cost and the interest on operating capital.

Derivation of gross margin

Gross margin was calculated by the difference between gross return and total variable costs which is expressed as:

$GM = GR - TVC$

Where,

GM = Gross margin; GR = Gross return; and

TVC = Total variable cost.

Financial profitability calculation

Profitability analysis was calculated by deducting all costs (variable and fixed) from gross return. To determine the net return for the crop, the following equation was used:

$$\pi = \sum_{i=1}^{n} (Py\,Y) - \sum_{i=1}^{n} (P_{xi} X_i) - TFC$$

Where,

π = Net return (Tk./ha);

Y = Quantity of output per hectare (kg);

P_y = Per unit price of the product (Tk./kg);

P_{xi} = Per unit price of the i^{th} input (Tk.);

X_i = Quantity of the i^{th} input used per hectare (kg);

TFC=Total fixed cost (Tk./ha); and

i = 1, 2, 3,……….., n (number of inputs)

Benefit cost ratio (BCR)

The benefit cost ratio (BCR) is a relative measure which is used to compare benefit per unit of cost. BCR was estimated as a ratio of gross return and gross costs. The formula of calculating BCR (undiscounted) is:

Benefit cost ratio (BCR) = Gross benefit/Gross cost

Determinants for the adoption of rice crop residue practice

Linear regression analysis is based on the assumption that the dependent variable is continuous. A very interesting and applicable method analyzing the dichotomous response variable is the linear logistic regression method. This method can be used not only to identify the factors but also to predict the probability of success. The general logistic model expresses a qualitative dependent variable as a function of several independent variables, both qualitative and quantitative. The logit model was estimated to identify the determinants for the adoption of crop residue practice. The implicit form of the model was as follows:

$$Z_i = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + U_i$$

Where,

Z_i = The adoption of crop residue of i^{th} farmer;

X = Vector of explanatory variables;

β_0= Constant; β_1, β_2, β_3……….β_6 = Coefficients to be estimated; and

U_i = Error term

The dependent variable is an indicator variable for the adoption of crop residue practices taking values either 0 or 1. The independent variables are captured as:

X_1 = Household size (number);

X_2 = Educational level of household head (years);

X_3 = Age of household head (years);

X_4 = Agricultural income (Tk.);

X_5 = Farm size (ha); and

X_6 = Non-farm income (Tk.).

To address the livelihood patterns of the respondents, the sustainable livelihood framework analysis including the asset pentagon (which is composed of five types of capitals namely, human capital, social capital, natural capital, physical capital and financial capital) were followed (DFID, 2000).

Results and Discussion

Pattern of retention of rice crop residue

The retention of crops was divided into three groups: wholly retention, partially retention and no retention. Although all three rice crops (i.e., Aus, Aman and Boro) and other crops such as, wheat, vegetables etc. were cultivated in the study areas as main crops, around 89 percent farmers used whole retention method basically for Boro rice (Table 1). The shortage of labour in season and the wage rate were important factors for the retention of crop residues.

Retention of rice crop residue by the distance of plots to the homestead

In case of no distance to homestead for Boro rice, whole retention method was used by 66.7 percent, partial retention method was used by 30.8 percent, and 2.5 percent farmers didn't use any retention method (Table 2).

Utilization of rice crop residues

Utilization of crop residue is important in cropping system as machines are increasingly used for harvesting the crop. Several utilization options are available to the farmers for the management of residues, which are: animal feed, cooking fuel, incorporation with tillage for organic fertilizer, mulching, burned at field etc.

Table 3 reveals that the highest proportion of households incorporated their crop residues with tillage for organic fertilizer in the study areas which was 76.1 percent. The lowest number of households burned their crop residues at field.

Table 1. Pattern of Retention of Crop Residue by the Sampled Farm Households

Crop	% of households		
	Whole	Partial	No
Boro rice	84.8	14.7	1.5

Source: Field survey, 2014

Interdependences of Rice Crop Residue Retention and Livestock Rearing

Due to crop residue practices, both rice crop and livestock were benefited through resource interdependences. Farmers used a large amount of their crop residue for the purpose of animal feeding. As a result, average milk yield was increased. Table 4 shows the benefit of livestock rearing for rice crop residue retention and the effects on the plots due to animal rearing. It was found that average milk yield was 1.2 L/day for without crop residue situation; and it was 1.5 L/day for the farmers who practice rice crop residue as the dairy cattle eats green grass. For without crop residue practice, calving period was 131.2 days and for the farmers with crop residue, such period was little bit longer, i.e., 136.6 days. Number of animals was increased as well due to crop residue practice. On the other hand, due to animal rearing on the plots with rice crop residue, almost all the respondents mentioned that they use less fertilizer due to cow dung droppings and soil surface becomes loose for livestock grazing. By this way, crop residue retention and livestock rearing are being interdependent.

Table 2. Retention of Crop Residue by Distance of Plot to the Homestead (in percentage)

Crop	No distance			Little far distance			Far distance		
	Whole	Partial	No	Whole	Partial	No	Whole	Partial	No
Boro rice	66.7	30.8	2.5	76.4	13.6	1.0	87.6	10.1	2.3

Source: Field survey, 2014

Table 3. Utilization of crop residues in the study area

Various uses of crop residue	% of farms followed	Rank in order
Animal feed	58.3	3
Stall feeding	12.4	5
Animal bedding	8.2	6
Cooking fuel	42.7	4
Incorporation for organic fertilizer	76.1	1
Burned at field	1.1	8
Mulching	65.3	2
Sold for cash	3.2	7

Source: Field survey, 2014

Benefits of Retention of Rice Crop Residues

Crop residues are good sources of plant nutrients and are important components for the stability of agricultural ecosystems. Farmers were being benefited through improving soil health, reducing fertilizer use, saving irrigation water, decreasing soil erosion, enhancing crop productivity, etc. Table 5 shows that among the many benefits, 98.9 percent farmers were benefited through improving soil health by such crop residue practices.

Impact of Rice Crop Residue Practice on the Succeeding Crop Productivity and Profitability

This section deals with the impact of rice crop residue practice on the productivity and profitability of the succeeding crop i.e., Aman rice, as farmers produce Aman rice followed by Boro rice. Productivity was calculated by the yield of the Aman rice grown in the field. Table 6 shows that the per hectare yield of Aman rice was found 4493.3 kg with the management of crop residue practice and 3244.6 kg without the management of crop residue practice in the study area. Thus, farmers practicing crop residue are more productive.

Output from Aman rice production included both the physical quantities of main product (i.e., paddy) and by-product (i.e., straw). Per hectare total returns were calculated by multiplying the total amount of product and by-product with their respective farm gate prices. Per hectare total cost of Aman production was estimated on full cost basis (Table 7).

Table 4. Interdependences of rice crop residue retention and livestock rearing

Items	Without crop residue practice	With crop residue practice
livestock rearing with crop residue retention		
Average milk yield	1.2 L/day	1.5 L/day
Calving period	131.2 days	136.6 days
Number of animal /farm	2.4	3.2
Crop plots with livestock rearing		
Items	Farm household responses (in %)	
	Yes	No
Less fertilizer use due to cowdung droppings	98.3	1.7
Loosen soil surface due to livestock grazing	93.6	6.4

Source: Field survey, 2014

Table 5. Benefits of rice crop residue retention in the study areas

Benefits	Responses (%)	Rank in order
Improves soil health	98.9	1
Reduces fertilizer use	87.4	4
Saves irrigation water	94.9	2
Controls carbon emission	31.9	8
Enhances productivity	53.2	7
Decreases soil erosion	86.8	5
Improves soil moisture	89.7	3
Increases soil water holding capacity	67.5	6

Total cost was the summation of total variable cost and total fixed cost which was estimated at Tk. 51557.8 for without crop residue management. But under rice crop residue management practice, per hectare total cost of Aman rice production was estimated at Tk. 56871.3. Gross return per hectare from Aman rice production included the monetary value of physical produces obtained from the production process. Per hectare gross return was found to be Tk. 65887.9 for without crop residue management, whereas it was estimated at Tk. 88719.3 under the status of crop residue management. Gross margin was estimated at Tk. 23875.0 for without crop residue and Tk. 42028.1 for with crop residue management (Table 7).

Table 6. Productivity of aman rice production

Practices	Main product (kg/ha)	By-product (kg/ha)
Without crop residue practice	3244.6	1447.1
With crop residue practice	4493.3	843.5
Impact on productivity (kg/ha)	1248.7**	
t-value	3.12	

Source: Author's estimation based on field survey, 2014, Note: ** Significant at 5 percent level.

Table 7. Profitability of aman rice production

Items	Cost and return (Tk./ha)	
	Without crop residue	With crop residue practice
A. Total variable cost	42012.9	46691.2
B. Total fixed cost	9544.9	10180.1
C. Total cost (A+B)	51557.8	56871.3
Quantity of Product (kg/ha) Price (Tk./kg)	3244.6 18.3	4493.3 18.3
Quantity of By-product (kg/ha) Price (Tk./kg)	1447.1 4.5	843.5 4.5
D. Gross return (Tk./ha)	65887.9	88719.3
E. Gross margin (D-A) (Tk./ha)	23875.0	42028.1
F. Net return (D-C) (Tk./ha)	14330.1	31848.9
G. Benefit cost ratio (D/C)	1.3	1.6
Impact on profitability (Tk./ha)	17518.8***	
t-value	2.27	

Source: Authors' calculation based on field survey, 2014, Note: *** Significant at 1 percent level

Net return from without crop residue management are lower than that of with crop residue management, as cost of production was lower for having crop residue management but per hectare yield is higher. So, per hectare profitability of crop residue management was higher than the without crop residue management. Benefit cost ratio (BCR) is a relative measure which is used to compare benefits per unit of cost. It helps to analyse the financial efficiency of the farmers. In case of without rice crop residue, the BCR (undiscounted) of rice farming was 1.3, and it was 1.6 for crop residue situation which indicates that Aman rice farming is more profitable under crop residue management practice.

Due to crop residue practice, productivity of Aman rice was increased by the amount of 1248.7 kg per hectare and it was significant at 5% level (Table 6); financial profitability of crop was enhanced by the amount of Tk. 17518.8 per hectare and it was also significant at 1% level (Table 7). Thus, it can be concluded that productivity and profitability from Aman rice production with crop residue management were higher than the Aman rice production without crop residue management practice.

Impact of rice crop residue on income generation

The annual gross income of the sampled farmers was estimated by adding the earnings from all income generating activities of the households during the reference year 2013. The activities were broadly classified into two categories: farm income and non-farm income. Farm income includes crop cultivation, livestock rearing, pond fish farming, etc. Non-farm income includes day labor, rickshaw pulling, vehicle driving, shop keeping, private teaching, etc.

It is evident from Table 8 that average annual income of rice farmers of without crop residue management was Tk. 179346.6 and for the crop residue management practicing farmers was Tk. 196366.3. It can be concluded that sampled farmers generated more than one-third of their income from crop farming. However, total annual income of sampled farmers was increased by the amount of Tk. 17019.7 due to crop residue management and the impact of having such crop residue practice on income was statistically significant.

Factors influencing the retention of rice crop residue practice

The result of logit regression model is presented in Table 9. In this study, the result of test of multicollinearity assures that such problem does not exist. Six variables included in the model, which were: household size, age, farm size, education, agricultural income and non-farm income.

Household size

The expected effect of this variable (household size) on crop residue practice has a negative coefficient but it was insignificant. So, it has a minor impact on adopting crop residue management.

Age of household head

The higher the age of household head, the greater the probability of adopting crop residue management practice than the comparatively lower age farmer. One unit increase in the age of household head will increase the log odds ratio of adopting crop residue practice by 1.123.

Farm size

The farmers with smaller farm size have greater probability of adopting crop residue practice than the large farmers. One-unit increase in farm size will decrease the log odds ratio of adopting crop residue management practice by 0.012.

Education level of household head

The education level of household head has a positive coefficient which was 0.190 but it was insignificant. So, it has a minor impact on adoption of rice crop residue practice.

Agricultural income

This result implies that the higher the household farm income, greater the probability of adopting crop residue management practice. One-unit increase in the level of farm income will increase the log odds ratio of adopting crop residue management practice by 1.0.

Non-farm income

The higher the household non-farm income, greater the probability of adopting crop residue practice in the study areas. One-unit increase in the level of non-farm income will increase the log odds ratio of adopting crop residue management practice by 1.0. Based on the empirical evidence from the analysis, the following points can be drawn:

- ❖ Adoption of rice crop residue management increases with the increase in the age of household head;
- ❖ Farmers adopt crop residue management with the increase in their farm size;
- ❖ Adoption of rice crop residue management increases with the increase in the farm income of the farmers; and
- ❖ Increase in non-farm income will increase the farmers' adoption of rice crop residue management practice.

Table 8. Average annual income of sampled farmers

Sources of income	Without crop residue practice		With crop residue practice	
	Amount (Tk.)	Percentage (%)	Amount (Tk.)	Percentage (%)
A. Farm income				
Crop cultivation	52434.8	30.9	75233.7	38.3
Livestock	39497.8	23.3	43266.3	22.1
Homestead	2769.3	1.6	4616.3	2.3
B. Non-farm income				
Service	42593.8	25.2	54142.2	27.5
Business	23587.6	13.9	13765.7	7.1
C. Others	8463.3	4.9	5342.1	2.7
Total annual income (A+B+C)	179346.6	100.0	196366.3	100.0
Impact on income (Tk.)	17019.7***			
t-value	2.38			

Source: Authors' calculation based on field survey, 2014, Note: *** significant at 1 percent level.

Table 9. Estimates of the logistic regression of determinants of crop residue practice of farm households

Variable	Coefficient (β)	Standard error	d.f.	Level of significance	Exponential of coefficient or odds ratio
Constant	-0.867	2.222	1	0.696	1.108
Household size (X_1)	-0.035	0.509	1	0.945	0.966
Age (X_2)	0.116	0.045	1	0.010***	1.123
Farm size (X_3)	-4.456	1.489	1	0.003**	0.012
Education (X_4)	0.190	0.123	1	0.122	1.209
Agricultural income (X_5)	0.00012	0.0005	1	0.001**	1.000
Non-farm income (X_6)	0.00014	0.0005	1	0.001**	1.000

Source: Author's estimation, 2014, Note: *** indicates significant at 1% level and ** indicates significant at 10% level.

Impact on livelihood pattern of the rice farmers

The sustainable livelihood framework includes the asset pentagon which is composed of five types of capital namely, human capital, social capital, natural capital, physical capital and financial capital (DFID, 2000). A sustainable livelihood is the outcome of inter and intra relationship between the components of the capitals. Changes in the asset position during one year are discussed as the transformation and improvement of the livelihood of the farmers.

Recently with the increased use of livelihood approaches in development, considerable attention has been given to develop methods for monitoring changes in all aspects of peoples' life which considered not only financial improvement but also socioeconomic impact on livelihoods and social well being of the target group of people (CARE, 2002). The sustainable livelihood framework presents the main factors that affect peoples' livelihood, and typical relationships between these.

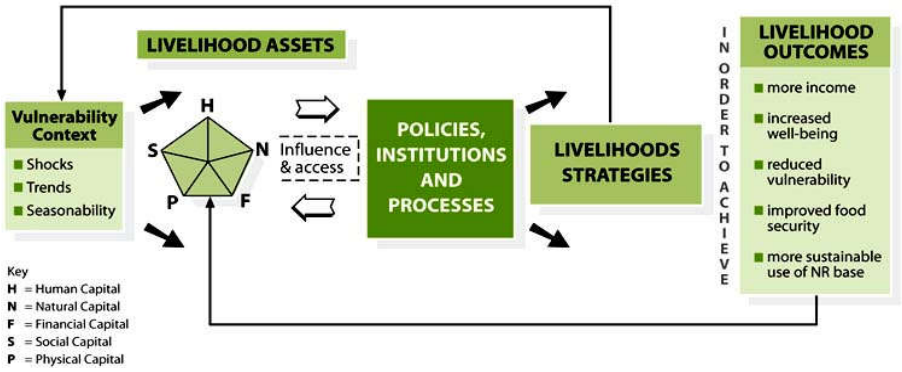

Diagram 1. Sustainable livelihood framework, Source: DFID, 2000.

Table 10 represents the changing nature of different capitals in farmers' livelihoods which represented

Table 10. Changes in farmers' capitals through adopting crop residue practice (% of farmers reported)

Items	Without crop residue	With crop residue
Human capital	53.0	75.1
Social capital	21.0	48.7
Financial capital	21.9	61.0
Natural capital	8.9	12.9
Physical capital	18.9	33.6

Source: Author's calculation, 2014

The findings revealed that households practicing crop residue in rice production have higher income and that farmers practicing crop residue had a positive impact on farm households' livelihood patterns in comparison to farmers without crop residue practice. better livelihood status than those who have not been practicing in the study areas. The asset pentagon approach shows that there is a noteworthy improvement based on different capitals (namely, human capital, social capital, natural capital, physical capital and financial capital) of farm households practicing integrated farming in comparison to mixed farming (Figure 1).

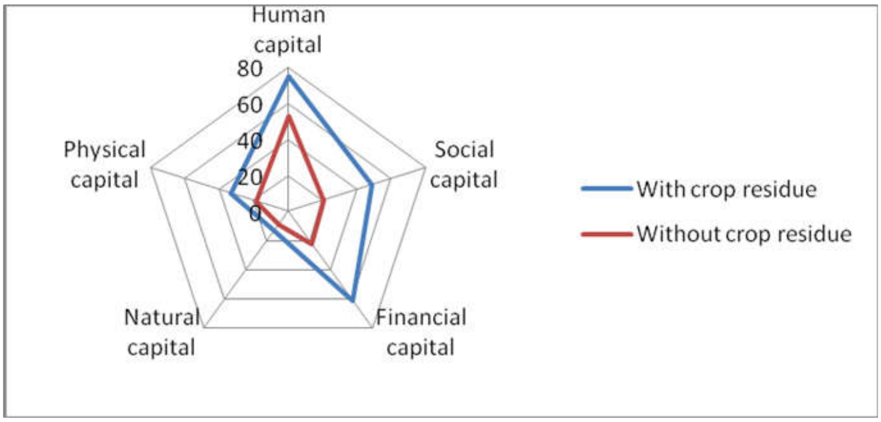

Figure 1. Asset pentagon of increases in capitals of farm households

Conclusion

The study reveals that crop residue retention was found for Boro rice production; and whole retention method was practiced in case of far distance plots from the homestead. Major utilization options of crop residue were identified which are: animal feed, cooking fuel, incorporation with tillage for organic fertilizer and mulching. However, farmers' perceptions about the use of crop residues were mostly adding organic matter to the crop field followed by mulching and feeding animal. The recycling of resources among crop retention and livestock has the great potential to return a considerable amount of plant nutrients to the soil in the rice based crop production systems. Due to crop residue practices, crop and livestock both were benefited through resource interdependences. The sampled farmers were benefited from retention of rice crop residues by improving soil quality, soil moisture, etc.; and farmers used fewer amounts of fertilizer, irrigation water, etc. for the succeeding crops. Consequently, succeeding crop productivity, profitability and annual income were increased significantly. The result of logit regression model shows that age of household head, farm size, agricultural income, and non-farm income were found as significant variables in explaining the variation in crop residue adoption of farm households. Noteworthy improvement was found based on different capitals of sampled farmers through asset pentagon approach. The study identified some problems which are: distance and ownership of plots, lack of scientific knowledge and method of crop residue management, and flood and other natural calamities. Finally, the study pointed out the recommendations as (i) farmers should be encouraged to utilize their rice crop residues which will facilitate their farming operations profitable; (ii) farmers should be informed about the various benefits of utilization of crop residues by extension agents or other government and non-government organizations to encourage for utilizing their rice crop residues efficiently which will improve soil fertility; (iii) farmers should be encouraged to attend training on the proper utilization of rice crop residues; and (iv) proper technique and technology should be provided to the farmers at reasonable cost so that those could be used to minimize the gap of yield of different crops in order to improve their livelihood.

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