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An economic analysis of sweet potato cultivation in some selected char areas of Bangladesh

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Abstract

A study was conducted to show existing sweet potato cultivation practices in respect to its economic viability at farm level in two selected char areas of Bangladesh during the period April-May, 2005. The study revealed 8% of the total cultivated area allocated and the farmers mostly used sandy loam to loam soil for its cultivation. On an average, farmers applied Cowdung, Urea, TSP, and MP at the rate of 1746, 62.5, 60.5 and 52.5 kg/ha, respectively. The average yield of sweet potato was 17.47 t/ha. Farmers of Sherpur got the highest yield of 18.81 t/ha due to intensive management practices with gross margin of sweet potato Tk 30736/ha with an average cost of Tk 28525/ha on total cost basis. Average benefit-cost ratios were 1.43, 3.21 and 1.62, 3.37 on full and cash cost basis. The return from sweet potato was observed to be positively related to the inputs like human and animal labour, vine, cowdung, Urea and MP, except TSP. The productivity effects of these inputs were positive whereas TSP effect was negative and statistically significant. It was evident that farmers could increase the output by judicious and higher allocation of labour, animal labour, cowdung, Urea and MP.

Keywords: Cropping pattern, Cost of production and Input-Output relationship, Benefit-cost ratio

Introduction

With a target of improving food shortage, third world countries give maximum efforts on producing merely staple food. Under subsistence farming, the yield of many root crops is very low but their genetic potential for producing increased yields is high and has not yet been fully exploited. In addition, some root crops are highly adaptable, producing reasonable yields from marginal lands. According to BBS (2003) about 5,12,000 metric tons of sweet potatoes are annually produced from 52631 hectares of land in Bangladesh. Reports from Tsou and Villareal (1982), Alkuine and Truang (1987) and Edmond and Ammerman (1971) stated facts about psychological and technical reasons for lower preference on sweet potato, particularly in developing countries. From sweet and French fry-type potato fried chunks and chips, flakes, canned and frozen items are being produced in the USA. Production of jam, jelly, juice, chips, sauce, flour, starch, animal feed etc from sweet potato variety may improve its existing status from subsistence level to a market-oriented crop. Leaves (vines) of the plant are very nutritious and consumed as vegetables and abundant source of animal fodder. Sweet potato processing has a great potential in tropical countries to augment available food resource (AVRDC, 1982). So, a favourable recommendation was outlined in the first international symposium on sweet potato (1982) for extending its present utilization to develop new food-products and upgrade its subsistence level to a market-oriented crop (Macky, 1989). In order to feed increasing people, sweet potato can be a vital substitute to present cereal varieties. Therefore, it requires a study to know the farmers' existing production technology, profitability and estimate the contribution of key variables to sweet potato production process.

Materials and Methods

The study was conducted at Malandaha Upazila (Jamalpur) and Sherpur Sadar during the period April-May, 2005. Location was selected through a discussion with Deputy Director and Upazila Agriculture Officers, Department of Agricultural Extension (DAE) in Jamalpur and Sherpur districts. Block Supervisors of the respective locations helped selecting respondents were selected in cooperation with the. The study area covered only six adjacent villages namely: Mahmudpur, Dormut and Nalerchar in Melandaha Uazila (Jamalpur) and Munshirchar, Kamarerchar and Soynumberchar (Sherpur) with 120 farmers equally taken from each district. Interview with checklist of question and tabular and statistical methods were used. Simple statistical attributes were also adopted. Necessary secondary information related to land use and concentrated sweet potato growing areas taken into consideration. To calculate profitability of sweet potato, following equation was used:

$$\prod = (P_{yi}Y_i + Z_i) - (TVC + TFC)$$

Where $\prod$ = profit per hectare from ith crop, P_{yi} = per unit price of main product of ith crop, Y_i = total quantity of main product per hectare of ith crop, Z_i = value of by product of ith crop, TVE = total variable cost, TFC = total fixed costs involved in producing sweet potato, i = 1 (i.e. 1= sweet potato),j= the number of individual inputs used for producing sweet potato,n=1,2,3,.....' (number of inputs used for producing the crops)
The interest on operating capital was calculated using the following formula (Miah, 1987)

Interest on OC = Alit

AI= Average investment = [Total investment]/2;
i = Interest rate per month which was 0.5 percent; and t = length of crop period in month (5 months was considered for sweet potato).

Functional analysis

To determine the contribution of variable input to the production of sweet potato, Cobb-Douglas functional form of regression equation was employed: $Y= a X_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{B5} X_6^{B6} X_7^{b7} eU$, The function was linearized by transforming it into the following logarithmic (Double-log) form:

$LnY=Lna+b_1lnX_1+b_2lnX_2+b_3lnX_3+b_4lnX_4+b_5lnX_5+b_6lnX_6+b_7lnX_7+U$, Where, Y = Gross return from sweet potato production (Tk/ha), a = Constant or intercept value

X_1 = Cost of labour (Tk/ha), X_2 = Cost of animal labour (Tk/ha), X3 = Cost of vine (Tk/ha)
X_4 = Cost of cowdung (Tk/ha), X5 = Cost of urea (Tk/ha), X6 = Cost of TSP (Tk/ha), X7 = Cost of MP (Tk/ha), U = Error term, b_1, ----------, b7= Coefficient of respective variable
Cobb-Douglas production function was specified to determine possible relationship between the production of sweet potato and inputs used. Inputs like human and animal labour, seeds (vine), cowdung, urea, TSP and MP were considered as the explanatory variables for the sweet potato in the production function analysis.

Results and Discussion

Land allocation for sweet potato cultivation

The average size of cultivated land was 1.09 and 1.33 hectare in Jamalpur and Sherpur, respectively. Average land allocation for sweet potato cultivation was 0.11 and 0.08 hectare in Jamalpur and Sherpur which were 10% and 6%, respectively of the total cultivated land (Table 1).

Table 1. Land allocation for Sweet potato cultivation in the study areas

Item	Jamalpur	Sherpur	Average
Cultivated land (ha/farm)	1.09	1.33	1.21
Land under Sweet potato cultivation (ha/farm)	0.11	0.08	0.10
% of total cultivated land	10	6	8

Source : Field survey (2005)

Variety used

Majority farmers (75%) preferred local (white) variety of sweet potato. On an average 20% of the farmers used local (red) variety while only a few percent used HYV cultivation. The result signified farmers' non-familiarity with modern varieties of sweet potato (Table 2).

Table 2. Percentage distribution of the farmers according to variety used

Variety used	% Farmer responded		
	Jamalpur	Sherpur	Average
Local (White)	70	80	75
Local (Red)	25	15	20
Others (HYV)	5	5	5
Total	100	100	100

Source: Field Survey (2005)

Land selection and planting time

Farmers of Jamalpur reported that medium high to medium low land with sandy to sandy loam soil was used for sweet potato cultivation, because soil is sandy in Jamalpur. While in Sherpur, farmers mainly used high to medium high land with only sandy loam soil (Table 3). Time of planting started in October and continued up to November. According to the opinion of the selected farmers, the best time of planting is October.

Planting method

Planting the vines on soil surface followed by ridging was reported as the best method by all of the respondents. Line to line and plant to plant distance was 35x30 cm in both Jamalpur and Sherpur. Farmers of the study area reported that vines grown in an area of 25 to 30 decimals sufficient to plant in an area of one hectare involved Tk. 2810/= (approximately). Majority of the farmers used vines collected from local markets or from the neighbor, but no or little preservation was reported.

Manuring, fertilizing and weeding

Table 3 revealed average quantity of cowdung, Urea, TSP and MP applied @ 1848, 60, 65 and 50 kg/ha in Jamalpur, while it was 1644, 65, 56 and 55 kg/ha of cowdung, Urea, TSP and MP in Sherpur. Usually the farmers applied Urea as first top-dresses in between 30-40 days after planting. For weeding, common practice by all farmers was between 20-40 days and 20-40 and 41-60 days after planting, in Jamalpur and Sherpur.

Harvesting and yield

Harvesting started in mid April to May (Table 3) with a duration of 170-200 days. The yields were found 16.12 and 18.81 t/ha in Jamalpur and Sherpur, respectively , much higher than national average 9.60t/ha (BBS, 2003).

Table 3. Existing production practices of sweet potato in the study areas

Activities	Location		
	Jamalpur	Sherpur	All
Land type	MHL-MLL	HL-MHL	Hl-MHl
Soil type	Sandy to	Sandy loam	Sandy to
	Sandy loam	-	Sandy loam
No. of ploughing	4-6	6-8	5-7
No. of laddering	8-10	12-16	10-13
Time of planting	Oct to Nov	Oct to Nov	Oct-Nov
Spacing (cm)	35x26	40x32	37x29
No. of weeding	1	1-2	1-2
Time of weeding:			
1st (20-40 DAP*)	1	1	1
2nd (41-60 DAP)	-	1	0-1
Manure and fertilizers (kg/ha)			
Cowdung	1848	1644	1746
Urea	60	65	62.5
TSP	65	56	60.5
MP	50	55	52.5
Spraying	Not applied	Not applied	Not applied
Irrigation	Not applied	Not applied	Not applied
Time of harvesting	April-May	April-May	April-May
Field duration (days)	170-200	170-200	170-200
Yield (kg/ha)	16125	18811	17468

**DAP = Days after planting, Source: Field Survey (2005)

Major cropping patterns of the survey plots

Among five different cropping patterns (Table 4), the most common one was sweet potato-Fallow-T. Amon-Jute (O)-Fallow in Jamalpur and sweet potato-T.Amon-Fallow covered by 20% and 25% in Sherpur, respectively. The average cropping intensities were 180% and 190%, respectively in Jamalpur and Sherpur, higher than the national average 178 (BBS, 2003). About 20% and 10% of the sweet potato plots of Jamalpur and Sherpur, respectively followed single cropping. This was mainly due to sole cultivation in sandy soils of char lands in both the study areas which are very much prone to flood from last part of June to September. Most of the char lands in Jamalpur remains inundated during this period.

Table 4. Major cropping pattern followed by the farmers in sweet potato survey plots of the study

Sl no	Cropping patter	% Farmer responded		
		Jamalpur	Sherpur	All
1	SP-Fallow-T. aman	30	35	32
2	SP-T. aman (Seed bed)-Fallow	20	25	22
3	SP-Jute (0)-Fallow	25	10	18
4	SP-Fallow-Fallow	20	10	15
5	SP-B. aus (2)-Fallow	5	20	13
Total		100	100	100
Cropping intensity of the survey pots (%)		180	190	185

Source : Field Survey(2005)

Cost of production sweet potato cultivation

The cost of production included all variable cost items like labour, draft power, vine, manures, chemical fertilizer etc used in the production of sweet potato. Both cash expenditures and imputed value of family owned inputs have been included in the estimate.

Cost of human labour

Human labour was required for different farm operations like land preparation, sowing/cutting of vine and planting, weeding, manuaring and fertilizing, ridging, harvesting and carrying, picking in producing sweet potato. Human labour constituted the highest cost (Tk.22720/ha) in Sherpur districts compared to Jamalpur districts (Tk.21920/ha).

On an average, 284 mandays per hectare were employed to produce sweet potato in Sherpur districts followed by 274 mandays per hectare in Jamalpur district. Out of these 284 mandays, 150 mandays were home supplied and 134 mandays hired in Sherpur and the corresponding figures for Jamalpur districts were152 man days and 122 man days respectively.

Cost of animal labour

Animal labour was employed for land preparation of sweet potato cultivation .The average per hectare 45 pair days were used for sweet potato cultivation, which was 25 pairs days home supplied and rest were hired in Jamalpur district while 22 pairdays home supplied and 18 pair days were hired in Sherpur districts.

Cost of vine

Cost of vines was the major item for producing sweet potato. On an average, per hectare Tk. 2970 was required for Jamalpur district, while Tk.2650 for Sherpur districts.

Cost of manure

In the study area, the growers of sweet potato used cowdung as the manure in the field at the time of land preparation. The farmers used 1848 kg per hectare costing of Tk.462 in Jamalpur district and 1644 kg per hectare whose price was Tk.437 in Sherpur district.

Cost of fertilizer

Urea, TSP and MP were used by the growers of sweet potato in study area. The average rate of Urea, TSP and MP in producing sweet potato were 60kg, 65kg and 50 kg/ha in Jamalpur district, while 65 kg, 56 kg and 55 kg in Sherpur district respectively.

Interest of operating capital

Interest on operating capital was calculated on the sum total of human labour cost, animal labour cost, cost of vine, cost of manure and fertilizers. It was estimated to be Tk. 674 and Tk.682 in Jamalpur and Sherpur districts respectively.

Cost of production

It was found in Table 5, that the cost of production of sweet potato was Tk.28189/ha (total cost) and Tk. 12550/ha (total variable cost) in Jamalpur and Tk. 28861/ha (total cost) and Tk. 13320/h (total variable cost) in Sherpur district on full and cash cost basis. It was revealed that the total variable cost per hectare was higher in Sherpur, compared to Jamalpur district. The reason for this variation in cost is mainly due to higher use of labour and fertilizer. The cost of human labour was the main cost item, contributing 76% of the total cost. The second major cost item was seed, which accounted for about 10% of the total cost.

Table 5. Cost and returns of sweet potato cultivation in the study areas

Items	quantity	Jamalpur (Tk/ha)	quantity	Sherpur (Tk/ha)	Average (Tk/ha)
1. Human lab (mandays/ha)					
Family	152	12160	150	12000	12080
Hired	122	9760	134	10720	10240
Sub total	274	21920	284	22720	22320
2. Animal labour (Pair day)					
Family	25	1500	22	1320	1410
Hired	20	1200	18	1080	1140
Sub total	45	7200	40	2400	2550
3. Vine purchased	2970	2970	2650	2650	2810
Manure and Fertilizer (kg/ha)					
Cowdung Family	1848	462	1644	411	437
Hired	-	-	-	-	-
Urea	60	360	65	390	375
TSP	65	780	56	672	626
MP	50	450	55	458	454
Sub total	-	2052	-	1931	1438
Total variable Cost (Tk/ha)	-	12550		13320	12935
Interest on operating capital (Tk/ha)		674	-	682	678
5. Cost of land use (Tk/ha)	-	1247	-	1560	1868
Total Cost (1 to 5) (Tk/ha)		28189	-	28861	28525
Yield (kg/ha)	16125	40313	18811	47028	43671
Price (Tk/kg)		2.50		2.50	
Gross return (Tk/ha)	-	40313	-	47028	43671
Net return (Tk/ha)	-	11378	-	17985	14682
Gross margin(Tk/ha)		27763	-	33708	30736
BCR : Full cost basis		1.43		1.62	1.55
cash cost basis		3.21		3.53	3.37

Source: Field Survey(2005)
Input price
Human labour (with meal): Tk= 80/day
Animal (with one labour): Tk. 60/pair days

Cowdung	=	Tk. 0.25/kg
Urea	=	Tk. 6.0/kg
TSP	=	Tk. 12.50/kg
MP	=	Tk. 10.00/kg

Gross returns were calculated by using the algebraic equation, as mentioned before. Table 5 revealed that the average yield of sweet potato per hectare was 16125 kg and 18811 kg in Jamalpur and Sherpur respectively. The farmers of Sherpur obtained higher yield than the farmers of Jamalpur. The yield variable might be due to intensive management, crop prices and the variation of soil fertility of the studied areas. The average gross return of sweet potato production was Tk. 40313/ha and Tk.47028/ha in Jamalpur and Sherpur respectively. It is also revealed that the average gross margin per hectare of sweet potato was Tk.27763 and Tk. 33708 in Jamalpur and Sherpur respectively.

Benefit Cost Ratio (BCR)

Benefit Cost Ratio (BCR) was used to see the efficiency of resources in the present study on both full and cash cost basis. The average estimated BCR in both the locations were 1.43, 3.21 and 1.62, 3.53 on full and cash cost basis, which implied farmers earning Tk. 1.43, Tk.3.21 and Tk.1.62, Tk.3.53 with the investment of Tk.1.00.

- Quantity of seed: Sweet potato vines grown in an area of 25 to 30 decimals was sufficient to plant an area of one hectare to land.
- Cost of land use for a period of one year was calculated as the rental value of land on the basis of the leasing out one hectare of land for a period of one year at Jamalpur and Sherpur was Tk. 1247 (Tk. 400/big ha) and Tk. 1560 (Tk. 500/big ha 1 big ha= 33 decimal receptively).

Contribution of factor inputs to production of sweet potato

The co-efficient of multiple determination (R^2) was 0.75 which meant that the explanatory variable included in the model explained 75 % of the variation in returns from sweet potato production. The F-value of the equation is significant at 1% level of confidence, implying that the variation in return from sweet potato production depends mainly upon the explanatory variable included in the model. The contribution of specified factors affecting production of sweet potato can be seen from the estimates of regression equation. The result showed that some of the co-efficient do not have the expected sign. However, the co-efficient for human labour, animal labour, vine, cowdung, TSP and MP were found to be significant. The magnitude of the co-efficient implied that these inputs had considerable effect on return from sweet potato production and it was statistically significant. The contributions of the selected factors to return from sweet potato are discussed below;

Input-output relationship

Labour (X_1): The value of the production co-efficient for family labour was 0.161, which was significant at 1% level. The positive sign indicated that return from sweet potato can be increased by using more human labour. The estimated co-efficient (0.161) revealed that 1% increase of human labour cost, keeping all other factors remaining constant, would uplift the gross return from sweet potato by 0.161%.

Animal labour (X_2): The estimated production co-efficient for animal labour was observed to be 0.131, which was significant at 1% level. It revealed that 1% increased animal labour cost, would increase the gross return by 0.131% when other factors were kept constant.

Seeds (X_3): The regression co-efficient of seed (vine) was 0.089 which was positive and insignificant. However, positive and insignificant result threw an idea that the return from sweet potato can be increased by using more seed (vine).

Table 6. Estimated values of co-efficient and related statistics of Cob-Douglas production model

Explanatory variables	Co-efficient	Standard error
Constants	4.98** (6.13)	0.813
Human labour(X_1)	0.161** (2.74)	0.059
Animal Labour(X_2)	0.131** (2.71)	0.048
Vine (X_3)	0.089 (1.57)	0.056
Cowdung (X_4)	0.129* (2.26)	0.057
Urea(X_5)	0.113* (2.16)	0.052
TSP (X_6)	-0.138* (-2.34)	0.059
MP(X_7)	0.166* (2.32)	0.023
R^2	0.75	
F	23.84**	
$\sum bi$	0.651	

Figures in the parentheses indicate "t" value
* significant at 5 percent level
** significant at 1 percent level

Manures and Fertilizer

The regression co-efficient of cowdung (X_4) 0.129, positively significant at 5% level. Sweet potato production may be increased by more use of cowdung. The co-efficient of ash (X_5) was 0.113, significant at 5 % level. It meant that 1% increase in ash cost with other factors remaining constant, would increase gross return by 0.113%. The estimated co efficient of TSP (X_6) -0.138 was significant at 5% level and negative sign indicated excessive use of TSP. If more TSP use would increase productivity, gross return would have been reduced. The co-efficient of MP (X_7) was 0.119 and it was significant at 5% level. It might be due to the indiscriminate use of MP and using more MP can increase return. Meanwhile, the average dose of fertilizer used in sweet potato production as surveyed in the present study was obviously high. The reasons for the increased fertilizer use by the sweet potato growers seemed to be based on higher doses of fertilizer will produce higher yield per unit area of land. Therefore, appearance of negative sign for input like TSP was observed.

Summation of elasticity of different inputs ($\sum bi$) was 0.651 which was also less than 1 but greater than zero ($0<0.651<1$). This indicated that the farmers, in general, allocated their resources in the zone of rational stage of production (stage II) where the diminishing returns to scale prevails, that is, if all the inputs specified in the function were increased by one percent, output would have increased by 0.651 percent.

Conclusion

Though being produced in indigenous varieties and traditional technologies, sweet potato is the important food item for the poorer section of people, especially in char areas of Bangladesh. The return from sweet potato was observed to be positively related to the inputs like labour, animal labour, vine, cowdung, Urea and MP except TSP. The productivity effects of labour, animal labour, cowdung, Urea and MP were positive, whereas TSP was negative and statistically significant. It was evident from the findings that farmers have an ample scope to increase the output by judicious and extended allocation of labour, animal labour, cowdung, Urea and MP. Besides, there is a great scope for improving existing technologies

by adoption of modern crop production technologies. Generally the grower themselves are the consumers for sweet potato. Marketing is also limited to the poorer section of the people in spite of its good nutritive value. There is a great need for processing technologies of food and feed products from sweet potato and popularize consumption pattern of sweet potato among the farmers. In this regard, efforts should be made for the dissemination of the processing technologies of sweet potato among the consumers through the extension personnel.

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