

**ECONOMIC PERFORMANCE OF GINGER (*Zingiber officinale* Rose.)  
CULTIVATION IN SOME SELECTED LOCATIONS OF BANGLADESH**

Q. M. SHAFIQU L ISLAM<sup>1</sup>, M. A. MATIN<sup>2</sup> AND S. HOSSAIN<sup>3</sup>

**Abstract**

The study was conducted in two ginger growing districts, namely Nilphamari and Khagrachari of Bangladesh during the period of 2009-10 to estimate the technical efficiency of ginger growers. The study revealed that ginger production was profitable and the average benefit cost ratio (BCR) was found 2.17. The estimated results showed that the average level of technical efficiency among the sample farmers was 85. This implies that given the existing technology and level of inputs, the output could be increased by 15 percent. In inefficiency model, the coefficient of farmer's education and experience in ginger cultivation was negative and significant. Sixty eight percent farmers produced outputs to the maximum frontier output level (81-95%). Farmers in the study area also mentioned some problems like incidence of root rot disease, high price of seed, insect infestation etc to its production.

Keywords: Economic performance of ginger cultivation, technical efficiency of farmers.

**Introduction**

Ginger (*Zingiber officinale* Rose.) is an important commercial spices crop in tropical and subtropical countries including Bangladesh. Among the spices crops, ginger is one of the important cash crops in Bangladesh. In chittagong Hill tracts region, it is a leading cash crop because of its greater potentiality of growing due to suitable climatic condition. The rhizome is used worldwide as spices for flavouring in a number of foods and food-products and also used in medicines (Lawrence 1984; Selvan *et al.*, 2002). It is rich in secondary metabolite, such as oleoresin (Bhagyalakshmi and Singh, 1988). In Bangladesh, it occupies an area of about 8045 hectares with the production of 57095 metric tons (BBS, 2007). It is used in almost all types of curry and is essential in cooking meat. It is found to be used in various pickles, cake and chatni and also used in preparing medicine like ayuratic, homeopathic, and also allopathic. It contains 80 percent water, 2.5 percent albuminoids, 12.3 percent carbohydrate, 1 percent fat, and 1.2 percent minerals (Ahmed, 1976). There are various reasons for the poor yield of ginger in Bangladesh which needs to be identified for appropriate research findings and policy intervention. But very little is known about its production technologies gains at farm level. This lack of information limits the researchers to identify and prioritize research needs and policy makers to adopt proper policy. The

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<sup>1&2</sup>Senior Scientific Officer and <sup>3</sup>Chief Scientific Officer, Agricultural Economics Division, Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh.

profitability of ginger cultivation in those areas should be measured. Therefore, the present study was undertaken with the following objectives:

- i. to know the existing cultivation practices of ginger;
- ii. to analyze the technical efficiencies of the ginger growers, and
- iii. to identify the constraints of ginger production in Bangladesh

**Table 1. Annual harvest price, area, production and yield of ginger for the period from 1990/91 to 2005/06 in Bangladesh.**

Year	Area (ha)	Production MT	Yield (t/ha)
1990-91	7020	42680	6.08
1991-92	7059	41535	5.88
1992-93	7067	41940	5.93
1993-94	7020	40160	5.72
1994-95	6907	39460	5.71
1995-96	6891	38985	5.66
1996-97	6899	38750	5.62
1997-98	6913	38665	5.59
1998-99	6877	38065	5.54
1999-00	6909	38265	5.54
2000-01	7296	41940	5.75
2001-02	7498	42655	5.69
2002-03	7573	42825	5.66
2003-04	7917	48185	6.09
2004-05	7715	49405	6.40
2005-06	8045	57095	7.10

Source: Price data from DAM, area, production and yield data from various issues of Yearbook of Agricultural Statistics

### Methodology

The study was conducted in two districts, namely one Nilphamari from plain land and another Khagrachari from hilly area during January to April 2009. Kishorgonj *Upazila* of Nilphamari district and Dighinala *Upazila* of Khagrachari district were purposively selected for the study. The study areas were selected according to intensive cultivation of ginger production. A total of 100 ginger farmers taking 50 farmers from each districts were randomly selected with the

help of DAE personnel for interview. Field investigators under the direct supervision of the researchers collected field level cross sectional data using pre-tested interview schedule. Data were taken on input costs, prices, yields and other necessary information.

Collected data were edited, summarized, tabulated, and analyzed to fulfill the objectives of the study. Tabular methods of analysis using different statistical tools were used in presenting the results of the study. Profitability of ginger production was examined on the basis of gross return, gross margin, and benefit cost analysis. The opportunity cost of family supplied labour was taken into consideration in estimating total cost or full cost. In calculating gross margin, all operating costs were considered as variable cost.

**Estimation of technical efficiency:** Technical efficiency is the ability of a firm to achieve maximum possible output with available resources. The stochastic Cobb-Douglas production frontier model was used for estimating technical efficiency of ginger producer in the study areas and the model is given below:

$$\ln Y_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \dots + \beta_n \ln X_{ni} + V_i - U_i$$

Where,  $\ln$  represents the natural logarithm; the subscript  $i$  represents the  $i$ -th farmer in the sample,  $Y$  represents the quantity of ginger harvest in kilogram,  $X_i$  represents the variable factors of production,  $\beta_i$  unknown parameters to be estimated,  $V_i$  assumed to be independently and identically distributed (iid) random errors, having  $N(0, \sigma_v^2)$  distribution,  $u_i$  are non-negative one sided random variables, called technical inefficiency effects, associated with the technical inefficiency of production of the farmers involved. It is assumed that the inefficiency effects are independently distributed with a half normal distribution ( $U \sim |N(0, \sigma_u^2)|$ ).

To examine the role of relevant farm specific variables in efficiency, the production inefficiency effect model can be written as follows:

$$U_i = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \dots + \delta_n Z_{ni} + W_i$$

Where,  $Z_i$  represents the farm specific inefficiency variable factors of production,  $\delta_i$  unknown parameters to be estimated,  $W_i$  unobservable random variables, which are assumed to be independently distributed with a positive half normal distribution.

The empirical Cobb-Douglas stochastic frontier production function with double log form can be expressed as:

$$\begin{aligned} \ln Y_i = & \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + \beta_6 \ln X_{6i} \\ & + \beta_7 \ln X_{7i} + \beta_8 \ln X_{8i} + v_i - u_i \end{aligned} \tag{1}$$

Where,

- Ln = Natural logarithm,
- Y = Yield of ginger of the i-th farm (kg/ha)
- X<sub>1</sub> = Human labour used by the i-th farm (man-days/ha)
- X<sub>2</sub> = Land preparation cost used by the i-th farm (Tk./ha)
- X<sub>3</sub> = Seed used by the i-th farm (kg/ha)
- X<sub>5</sub> = Urea used by the i-th farm (kg/ha)
- X<sub>6</sub> = TSP used by the i-th farm (kg/ha)
- X<sub>7</sub> = MP used by the i-th farm (kg/ha)
- X<sub>8</sub> = Insecticides cost used by the i-th farm (Tk./ha)
- X<sub>9</sub> = Irrigation cost used by the i-th farm (Tk./ha)
- X<sub>10</sub> = Dummy for source of seed
- β's and η's are unknown parameters to be estimated
- v<sub>i</sub> - u<sub>i</sub> = error term

V<sub>i</sub> are assumed to be independently and identically distributed random errors, having N (0, σ<sub>v</sub><sup>2</sup>) distribution.

#### Technical inefficiency effect model

The u<sub>i</sub>'s in equation (1) are non-negative random variables, called technical inefficiency effects, assumed that to be independently distributed such that the technical inefficiency effects for the i<sup>th</sup> farmer, u<sub>i</sub>, are obtained by truncation normal distribution with mean zero and variance σ<sub>u</sub><sup>2</sup>, such that

$$u_i = \delta_0 + \delta_1 z_{1i} + \delta_2 z_{2i} + \delta_3 z_{3i} + \delta_4 z_{4i} + \delta_5 z_{5i} + W_i \quad (2)$$

where,

- z<sub>1</sub> = Land size of the i-th farm operator (ha)
- z<sub>2</sub> = Age of the i-th farm operator (years)
- z<sub>3</sub> = Education of the i-th farm operator (year of schooling)
- z<sub>4</sub> = Experience in ginger farming of the i-th farm operator (year)
- z<sub>5</sub> = Family size of the ginger growers of i-th farm operator (number)
- δ's are unknown parameters to be estimated

W<sub>i</sub> are unobservable random variable or classical disturbance term, which are assumed to be independently distributed, obtained by truncation of the normal distribution with mean zero and unknown variance σ<sup>2</sup>, such that u<sub>i</sub> is non-negative.

The β, η and δ coefficients are unknown parameters to be estimated, together with the variance parameters which are expressed in term of

$$\sigma^2 = \sigma_u^2 + \sigma_v^2 \quad (3)$$

$$\text{and } \gamma = \sigma_u^2 / \sigma^2 \quad (4)$$

$\gamma$  is the ratio of variance of farm specific technical efficiency to the total variance of output and has a value between zero and one.

The estimates for all parameters of the stochastic frontier (1) and inefficiency model (2) were estimated in a single stage by using the Maximum Likelihood (ML) method. The econometric computer software package FRONTIER 4.1 (Coelli, 1996) was applied to estimate the parameters of stochastic frontier models using the ML.

## Results and Discussion

### Agronomic performance

On an average, 6.28 number of ploughings and 4.10 number of ladderings were done by the farmers of Nilphamari for ginger cultivation. But the farmers of Khagrachari prepared their land by 2.06 number of spaddings (Table 2). Eighty six percent farmers used insecticides. It was observed that all the farmers of Nilphamari used insecticides. Sowing period ranged from 3<sup>rd</sup> week of April to 1<sup>st</sup> week of June in Nilphamari and the farmers of Khagrachari completed their sowing from 3<sup>rd</sup> week of April to 4<sup>th</sup> week of May. It was also observed that 50% farmers completed their sowing within the month of April, 43% at the end of May and rest 7% farmers sown their land in the month of June.

**Table 2. Agronomic practices of ginger cultivation of the sample farmers in the study areas.**

Activities	Nilphamari	Khagrachari	All
Ploughing (average)	6.28	-	-
Spadding (average)	-	2.06	-
Laddering (average)	4.10	-	-
Weeding (average)	3.72	2.32	3.02
Earthing (average)	2.98	0.10	1.54
Insecticide application (%)	100	72	86
Irrigation (%)	72	-	36
Sowing (%):			
April	36	64	50
May	50	36	43
June	14	-	7
Weeding number (%):			
One	-	8	4
Two	-	54	27
Three	42	38	40
Four	42	-	21
Five	16	-	8

All the farmers followed the method of line sowing. Weeding in ginger field was done by all the farmers. All the farmers in both the areas weeded their land ranging from one to five weedings. The farmers of Nilphamari weeded their land ranges from three to five times, but the farmers of Khagrachari weeded only one to three times.

### Input use pattern

The pattern of input use is presented in Table 3. On an average, ginger farmers used 267 man-days of human labour per hectare of which 45% were family supplied. The farmers of Nilphamari used higher human labour (299 man-days/ha) compared to Khagrachari farmers (235 man-days/ha). It was due to increased number of labour used for more cowdung application and better management practices. On an average, 1271 kg of seed was used per hectare which was found higher in Nilphamari than Khagrachari. The farmers used 75% seed from their own sources. On an average, farmers used 5310 kg manures/ha, which was more in Nilphamari and very little amount was used in Khagrachari. Farmers in the study areas also used chemical fertilizers like urea, TSP, and MP at the rate of 122 kg, 137 kg, and 145kg per hectare, respectively. It was much lower than the recommended doses of i.e., urea (300-320) kg/ha, TSP (260-280) kg/ha, and MP (290-310) kg/ha (Modern cultivation practices of ginger in the hilly areas, 2009).

**Table 3. Level of input use per hectare for ginger cultivation in the study areas.**

Type of input	Nilphamari	Khagrachari	All
Human labour (man-days):	299	235	267
Own	84	154	119
Hired	215	81	148
Land preparation cost (Tk./ha)	11004	19033(169)*	15019
Seed (kg./ha):	1467	1075	1271
Own	1094	808	951
Purchased	373	267	320
Manures (kg/ha):	9445	1175	5310
Own	6026	879	3452
Purchased	3419	296	1858
Oilcake	24	-	12
Fertilizers (kg/ha):			
Urea	143	101	122
TSP	223	51	137
MP	282	7	145
Zn	4	-	2
Zipsun	10	-	5
Insecticides (Tk.)	7363	2120	4742
Irrigation (Tk.)	3085	-	1543

\*Parentheses indicates the number of labour used for land preparation

The Nilphamari farmers used more fertilizers than Khagrachari. They also used small amount of Zn, Oilcake, and Zypsum which were absent in Khagrachari farmers. Insecticides were used in both areas, but it was more than three times used in Nilphamari. Only the farmers of Nilphamari used irrigation for ginger production.

### Cost of ginger production

The cost of production included different variable cost items like land preparation, human labour, seed, manure, fertilizer, insecticides, irrigation, interest on operating cost and rental value of land. Both cash expenditure and imputed value of family supplied inputs were included in the analysis and shown in Table 4.

**Table 4. Cost of ginger cultivation by the sample farmers in the study areas.**

<i>(Taka per ha)</i>			
Cost items	Nilphamari	Khagrachari	All area
Land preparation:	11004	19033	15019(7)
Own	8738	11375	10057
Hired	2266	7658	4962
Human labour:	35888	26334	31112(17)
Own	10107	17316	13712
Hired	25781	29018	17400
Seed:	138549	54133	96341(51)
Own	103230	40655	71943
Purchased	35319	13478	24398
Mulching materials:	5581	-	2791(1)
Own	3614	-	1807
Purchased	1968	-	984
Manures:	4723	588	2656(2)
Own	3013	440	1727
Purchased	1710	148	929
Oilcake	826	-	413
Fertilizers:	18344	3500	10922(6)
Urea	1718	1212	1465
TSP	10172	2029	6100
MP	4895	259	2577
Zn	325	-	163
Zypsum	408	-	413
Insecticides	7363	2120	4742(3)
Irrigation	3085	-	1543(1)
Interest on operating capital (8% for one year)	10296	5583	8093(4)
Land use cost	17154	11250	14538(8)
Total cost:			
Cash cost basis	128702	88853	101167(53)
Full cost basis	251988	122541	187602

*Figures in the parentheses are percentage of total cost.*

It revealed that highest cost was incurred for seed (51%) followed by human labour (17%), land use cost (8%), land preparation (7%), and fertilizers (6%) when family supplied inputs were valued at market rate. Mulching cost was only observed in Nilphamari. It was also found that all the farmers used straw as a mulching material.

In Khagrachari, land preparation cost was found more than 1.5 times from Nilphamari. Because the farmers of Khagrachari prepared their land by cutting the trees, firing, cleaning and then spading by human labour. Seed cost was observed more in Nilphamari, it was due to more seed rate and high price of seed. The average cost of production in full cost basis was found Tk. 187602/ha, which was found more than two times higher in Nilphamari. Because all costs except land preparation were observed higher in Nilphamari.

### Profitability

Table 5 depicted that the sample farmers received on an average 7886 kg/ha of ginger. Though the main yield was found higher in Khagrachari, when the yield of mother rhizome (1142) kg/ha was included higher yield was observed in Nilphamari. Similar amount of mother rhizome and more than 2 t/ha less amount of main yield was found by the farmers of Nilphamari (Ahmed, 1990). The average gross return from ginger production was found Tk. 407912/ha and gross margin on full cost basis Tk. 220310/ha.

**Table 5. Profitability of ginger cultivation in the study areas.**

Items	Nilphamari	Khagrachari	All
Main yield (kg/ha)	7064	7566	7315
Yield of mother rhizome (kg/ha)	1142	-	571
Total yield (kg/ha)	8206	7566	7886
Gross return (Tk./ha)	461450	354373	407912
Total cost (Tk./ha):			
Cash cost basis	128702	88853	101167
Full cost basis	251988	122541	187602
Gross margin (Tk./ha):			
Cash cost basis	332748	280741	306745
Full cost basis	209462	231832	220310
Benefit cost ratio:			
Cash cost basis	3.59	5.08	4.11
Full cost basis	1.83	2.89	2.17
Cost of ginger (Tk./kg):			
Cash cost basis	15.68	9.73	12.58
Full cost basis	30.71	16.20	23.79
Return from ginger (Tk./kg)	56.23	46.84	51.73

Source : Field survey 2010



The benefit cost ratio was estimated at 4.11 and 2.17 on cash cost basis and full cost basis, respectively. Total cash cost was found higher in Nilphamari due to more inputs used which was discussed earlier. As a result, benefit cost ratio was lower in Nilphamari on both cash and full cost basis. The cost of grain was Tk. 12.58 on cash cost basis and Tk. 23.79 on full cost basis. On an average, benefit from per kilogram ginger production was Tk. 51.73.

#### Maximum likelihood estimates of farm specific stochastic frontier production function and inefficiency model

The maximum likelihood estimates for parameter of the Cobb Douglas Stochastic production function frontier of ginger was presented in Table 6. Most of the parameters were statistically significant and positive. The empirical result indicated that the co-efficient of human labour and cowdung use were found positive and significant at 5 percent level, while use of urea was found positive but significant at 10 percent level. In other words, the co-efficient of human labour, cowdung, and urea were 0.041, 0.624, and 0.104, respectively.

**Table 6. Maximum likelihood estimates of the stochastic Cobb-Douglas frontier production function and technical inefficiency model for ginger.**

Independent variables	Parameters	Coefficient	Standard Error	t-ratio
Stochastic frontier:				
Constant	$\beta_0$	3.25***	1.09	2.98
Ln Human labour (man-days/ha)	$\beta_1$	0.041**	0.019	2.10
Ln Land preparation (Tk/ha)	$\beta_2$	-0.459	0.402	-1.14
Ln Seed (Tk./ha)	$\beta_3$	0.245	0.182	1.35
Ln Cowdung (Tk./ha)	$\beta_4$	0.624**	0.249	2.50
Ln Urea (kg/ha)	$\beta_5$	0.104*	0.061	1.71
Ln TSP (kg/ha)	$\beta_6$	0.499	0.324	1.52
Ln MoP(Tk./ha)	$\beta_7$	-0.172	0.118	-1.45
Ln Insecticides (Tk./ha)	$\beta_8$	0.386	0.357	1.08
Dummy for source of seed	$\beta_9$	0.419	0.398	1.03
Technical inefficiency model:				
Constant	$\delta_0$	0.0315	0.029	1.06
Age	$\delta_1$	0.117	0.093	1.28
Education	$\delta_2$	-0.235*	0.131	-1.80
Experience	$\delta_3$	-0.319**	0.153	-2.08
Family size	$\delta_4$	0.173	0.138	1.25
Variance parameters:				
Sigma-squared	$\sigma^2$	0.320		0.097
Gamma	$\gamma$	0.978		0.562
Log likelihood function			195	

\*\*\*, \*\* and \* indicate the significant at 1%, 5%, and 10% level of probability, respectively.

It implied that this inputs had a significant and positive impact on ginger production. The yield of ginger would increase by 0.041, 0.624, and 0.104 percent if farmers apply 1% additional human labour, cowdung, and urea, respectively. The technical in-efficiency model, the co-efficient of farmers education and experience was negative and significant. It means that technical inefficiency in ginger production decreases with the increase in farmers education and experience. Similar observation was found in various earlier studies (Coelli and Battese, 1996, Sharif and Dhar 1996, Seyoum *et al.*, 1998).

The estimated value of variance ( $\sigma^2$ ) was significantly different from zero which indicated a good fit and correctness of specified distributional assumption.

#### **Technical efficiency and its distribution**

It is evident from Table 7 that the mean value of technical efficiency was 0.85 with a range from 0.61 to 0.95%. About 68% farmers produced outputs which were very close to the maximum frontier output level (81-95%). This implies that on an average, the ginger growers in the study areas were producing ginger about 85 percent of potential frontier production levels, given the levels of their inputs and the technology currently being used. This also indicated that there existed an average level of technical inefficiency of 15 percent.

**Table 7. Technical efficiency of ginger growers in the study areas.**

Technical efficiency level	No of farmers	% of total farmers
61-70	15	15
71-80	17	17
81-90	21	21
91 and above	47	47
Mean efficiency		0.85
Maximum		0.95
Minimum		0.61

#### **Constraints**

Although yield of ginger was low but also observed a profitable crop, there are several constraints to its higher production. The constraints are shown in Table 8. It was found that all the farmers responded incidence of root rot disease ranked first as a problem of ginger production. Other major constraints were high price of seed, insect infestation, lack of capital etc. were also opined by the ginger farmers.

**Table 8. Constraints to ginger cultivation in the study areas.**

Items	Percent farmers' responded			Rank
	Nilphamari	Khagrachari	All	
Incidence of root rot diseases	100	94	97	1
High price of seed	72	44	58	2
Insect infestation	58	46	52	3
Lack of capital	42	58	50	4
Insecticides not work properly	58	28	43	5
Lack of quality seed	46	34	40	6
High price of fertilizers	34	26	30	7
High price of insecticide	38	18	28	8
Others*	32	22	27	9

\* It means excess weed, lack of labour and timely rainfall.

### Conclusion and Recommendations

The ginger production in the study areas is profitable. Ginger farmers received high return on its investment, but it did not reach the optimum level. Appropriate level of input use and time of operation is essential for achieving higher yield and profits, but the technology employed by the farmers were not at the level of recommendation. The estimated technical efficiency for ginger varies from 61 to 95%, with an average efficiency 85%. This implies that the output per farm can be increased, on an average, 15% without incurring any additional production cost. The co-efficient of human labour, cowdung, and urea were found positive and significant. The coefficients of farmer's education and experience were negative and significant. Most of the farmers produced output to the maximum frontier output level (81-95%).

- ▶ Availability of modern variety seed and production technology to the farmers, yield and production can be increased which may help to increase their income.
- ▶ Farmers require fair price of seed, fertilizers and insecticides.
- ▶ Farmers desire to get quality seed, disease and insect tolerant variety for getting higher return from ginger production.

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