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# Protection and Comparative Advantage of Milk Production through Rearing of Cross-Bred Dairy Cattle in Bangladesh: A Policy Analysis Matrix

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## Abstract

The study aims to determine the policy incentive in terms of protection and efficiency of production through a comparative advantage in the milk sector by using policy analysis matrix (PAM) on the basis of field level primary data from different agro-ecological zones of the country. From policy analysis matrix in-line with private/financial profit, social/economic profit and policy divergences/transfers, various protection coefficients such as NPCO, NPCI, EPC and PC and competitiveness coefficients such as DRC, SCB were derived to measure the level of protection and comparative advantage in the milk sector of Bangladesh. The results of the policy transfer and protection coefficients (NPCO, NPCI, EPC and PCO criteria) shows that milk production in Bangladesh is subsidized for inputs (NPCI<1) and taxed for the product/output (NPCO>1). The net effect of output taxation and input subsidy resulted in net taxation on value added (EPC>1) for policy goal of self-sufficiency. From the efficiency perspective, the estimated economic profitability criteria and competitiveness indicators (DRC, SCB) exhibit that Bangladesh has a comparative advantage in milk production domestically for import substitution.

**Keywords:** Milk, Policy Analysis Matrix, Protection and Comparative Advantage

## 1. Introduction

Livestock is one of the most important sub-sectors of agriculture sector that plays a significant role in the economy of Bangladesh. It is vital in terms of employment generation, animal protein sources, cash income, manure and driving source of agricultural production. Nowadays, the livestock population in Bangladesh is 539.72 lakh where cattle are 236.36 lakh, and buffaloes are 14.64 lakh (DLS, 2015). In the fiscal year 2014-15, total milk production was 69.70 lakh metric tons whereas demand for milk 144.81 lakh metric ton. Per capita, milk availability was 122 ml/day, and the deficiency was 75.11 lakh metric ton (DLS, 2015). The demand for milk is aggravating day after day. Uddin *et al.* (2011) in a study focused on dairy cattle population per farm and found that the number of dairy cattle per family decreased over time. Irrespective of regions, per household, average milk production varied from 311 to 762 liters. In the same study, he stated that drinking of milk did not show any consistent trend over time and the amount of intake was much higher than the national average (Uddin

*et al.*, 2011). Rabbani *et al.* (2004) conducted a socioeconomic study on the participation of rural people in dairy production, and he showed that large farmers raised the cross-bred dairy cattle and small farmers raised the local breed. Besides, the empirical experiment has shown that rapid improvement of the local cattle by cross-breeding produced satisfactory milk production and surviving well under the traditional conditions. Kuddus (2006) in a study found that net return of rearing dairy cattle in the commercial region was significantly higher than that of other regions due to the rearing of cross-bred cows and feeding them high-quality feed. The demand for milk and milk products are increasing due to rapid population growth, and educated people are much conscious about nutrition. In fact, in most of the cities and towns, milk supply is scanty instead of its high demand.

Every year Bangladesh imports a huge amount of powder milk from abroad. The neighboring country India, hold the top position in the list of exporting of milk to Bangladesh. For this, the country has to pay millions of dollars for trading milk. In terms of milk production, India holds the second position just behind the USA. United States of America, India, China, Brazil and New Zealand produced 91.30, 60.60, 35.70, and 18.90 billion kilograms, respectively every year. On the other hand, New Zealand secured the apex position in the hierarchy of global milk exporting countries. New Zealand exported milk in terms of monetary value US\$ 5.6 billion which was 20.4% of the total milk export. Alam *et al.*, (2007) conducted a study and found that the comparative advantage of milk production in Bangladesh was 1.11 indicating that milk production was not profitable and importation of fresh milk or powder milk was better than the production of milk domestically. But that study was performed more than one decade ago. For producing a more update and authentic information, research work was needed. The study was able to find out the comparative advantage of milk production in Bangladesh and suggests some policy guidelines which might assist the researchers, academicians, planners and the farmers.

#### **Objectives of the Study: the study has the following specific objectives**

- i. To measure the comparative advantage of milk production in Bangladesh;
- ii. To examine the policy implications arising from the findings.

#### **2. Methodology for Policy Analysis Matrix (PAM)**

In welfare economics, there are two types of theoretically right and simply understandable measures that are used for measuring policy impact. First, the analysis focuses on the private and social cost of public sector investment. Popular measure in this area is the benefit-cost analysis which includes further three measures, which are internal rate of return (IRR), net present value (NPV) and the benefit-cost ratio (BCR) (Gittinger, 1982, Kanapiran and Fleming, 1999). Secondly, analysis concentrated on the static effects of price-distorting policies. In the analysis of trade, price policy incentives, and comparative advantage, it has become customary to estimate the nominal protection coefficients (NPC), effective protection coefficients (EPC), domestic resource cost (DRC) although there have some limitations for estimation (detail see Corden, 1979; Balassa and Schydrowsky, 1972; Bruno 1967, 1972 ; Byerlee and Morris, 1993). A new summary measure, the policy analysis matrix (PAM) that prevents the limitations of previous measures and includes all these ratios is used as an analytical technique for this study to measure the comparative advantage and policy distortions in the milk sector of Bangladesh (Monke and Pearson, 1989). In the near past lot of studies used PAM for measuring comparative advantage and policy distortions in different countries including Bangladesh.

The policy analysis matrix is a system of double-entry bookkeeping analytical framework developed by Monke and Pearson (1989) and improved by Masters and Winter-Nelson (1995) for measuring the impact of policy on competitiveness and farm-level profits, the influence of investment policy on economic efficiency and comparative advantage, and the effects of agricultural research policy on changing technologies. PAM provides complete and consistent coverage to all policy influences on costs and returns of agricultural production. The primary strength of the PAM is that it allows varying levels of disaggregation and it makes the analysis of policy-induced transfers straightforward. The PAM also makes it possible to identify the net effect of a set of complex and contradictory policies and to sort out the individual effects of those policies. Along with strength, PAM also suffers some sorts of weaknesses, one of which is the assumption of fixed input-output coefficients. (Nelson and Panggabean, 1991).

The PAM contains two accounting identities (Table 1), one as the difference between revenues and costs which define the profitability and the other measuring the effects of divergences (distorting policies and market failures) as the difference between observed parameters and parameters that would exist if the divergences were removed. The PAM is based on the estimation of budgets by using market prices and social prices (Monke and Pearson, 1989). The data in the first row of table provide a measure of private profitability (D), which assesses the values of outputs and inputs using private prices, which are equal to the actual or expected financial (market) prices for goods and services that are bought or sold by farmers, merchants, or processors in the agricultural system. The private or actual market prices thus include the underlying economic costs and valuations plus the effects of all policies and market failures.

The private profitability illustrates the competitiveness of the agricultural system, given current technologies, output and input prices and policy transfers (Monke and Pearson, 1989; Masters and Winter-Nelson 1995; Nelson and Panggabean, 1991). The second row of the matrix in the table measures the social profits (H) that reflects social opportunity costs. Social profits measure efficiency or inefficiency of resources use and provide a measure of comparative advantage. To determine the second row of the matrix, social prices (which reflect the underlying scarcity and thus the optimal allocation of resources) are used for valuation of inputs and outputs. Social value/price demonstrates a benchmark policy environment for comparison as these are considered those that would hypothetically occur in a free market without policy interventions (Monke and Pearson, /1989; Masters and Winter-Nelson, 1995). The second accounting identity, in the third row of the table, measures the divergences, which is defined as the difference between the first and second rows. The difference between private (actual market) and social (efficiency) values of revenues, costs, and profits can be explained by the policy interventions or existence of market failure. If market failure correction policies by the government do not exist (or are negligible) than any differences between the first row and the second row must be caused by distorting policies. But if the efficient policies by the government for correcting the effect of market failure create greater income and thus correct divergences by reducing the difference between private and social valuations. The third row also reflects transfers between producers on one side and government treasury and consumers on the other side (Monke and Pearson, 1989; Masters and Winter-Nelson, 1995).

An important indicator for calculating the protection rate by a different ratios such as NPC (NPCO and NPCI) and EPC, and also DRC, SCB ratio for measuring comparative advantage used in this study. These are defined as;

**Nominal protection coefficient (NPC):** One of the most widely used simplest and easiest measure of price distortions is the nominal protection coefficient (NPC) (Corden, 1971; Balassa and Schydlosky, 1972; Gulati et al., 1990; Taylor and Phillips, 1991; Sadoulet and de Janvry, 1995; Fang and Beghin, 2000), defined as

$$NPC_i = P_d^i / P_r^i * ER$$

From the PAM table, NPC is the ratio of private price with a comparable social price of the commodity. This ratio indicates the impact of policy on the divergence between the two prices for output (NPCO) and tradable inputs (NPCI). Subsidies to output are indicated by NPCO (which is A/E) if its value larger than one, and inputs subsidies lead to NPCI (which is B/F) if its value smaller than one (Fang and Beghin, 2000).

If  $NPC > 1$ , producer are protected, and consumers taxed, from a strictly trade theoretic point of view, suggest inefficiency in producing and the price is heavily affected by government policies or other factors of that commodity. Thus the welfare (and efficiency) of the economy can be improved by letting domestic price secure around the appropriately adjusted world price or by eliminating discriminatory policy interventions. (Corden, 1979; Timmer, 1989; Anwar, 2004; Shilpi, 1996).

If  $NPC < 1$ , producer are taxed and consumers subsidized may be due to market failure or government intervention, and

If  $NPC = 1$ , the structure of protection is neutral.

### Effective protection coefficient (EPC)

EPC is such type of measure defined as the ratio of distorted tradable value added at market price to its undistorted value at border prices. EPC captured the effect of government policies (tax and subsidy) on input as well as output market (Bureau and Kalaitzandonakes, 1995; Sadoulet and de Janvry, 1995; Anwar, 2004).

The formula for EPC is;

$$EPC = Va_i^d / Va_i^b = P_i^d - \sum_j a_{ij} p_j^d / P_i^b - \sum_j a_{ij} p_j^b$$

From the PAM table, EPC is a ratio of value added in private prices (A-B) to value added in social prices (E-F). This coefficient indicates the degree of policy transfer from the output and tradable input distortions. A value greater (or less) than one indicates a net subsidy (or net tax) to value added (Beghin and Fang, 2002; Monke and Pearson, 1989).

### Domestic resource cost (DRC)

The domestic resources cost (DRC) is widely used in developing countries for measuring comparative advantage, efficiency and guiding for policy reforms. The DRC was developed simultaneously in the 1960s by Bruno (1965) in Israel and by Krueger (1966) in the United States. The DRC, defined as the shadow value of non-tradable inputs used in an activity per unit of tradable value added. In another way, it's the ratio of the shadow value of domestic resources and non-traded inputs to the net foreign exchange earned or saved by producing the good domestically (Morris, 1989; Masters and Winter-Nelson, 1995; Sadoulet and de Janvry, 1995; Anwar, 2004).

The formula is;

$$DRC = \sum_{j=k+1}^N a_{ij} p_j^{dni} / P_i^b - \sum_{j=1}^K a_{ij} p_j^b$$

DRC has been rigorously used for measuring comparative advantage and guiding for policy reform in developing countries (World Bank, 1991; Appleyard 1987; Morris 1990; Gonzales et.al., 1993; Alpine and Pickett, 1993) as well as in academic research (Nelson and Panggabean, 1991; Nishimizu and Page, 1986; Weiss, 1991). However, Master and Winter-Nelson showed that the DRC might be biased against activities that rely heavily on domestic non-traded factors, (e.g. land and labour). The proposed social cost-benefit (SCB) is a good alternative for the DRC, which accounts for all cost and avoids classification errors in the calculation of DRC (Masters and Winter-Nelson 1995; Fang and Beghin, 2000). From PAM framework SCB is defined as (F+G)/E. The interpretation of SCB is same as like DRC. In the following table, policy analysis matrix (PAM) is shown:

Table: Policy analysis matrix (PAM)

Items	Revenue	Costs		Profit
		Tradable inputs	Domestic factors	
Private prices	A	B	C	D
Social prices	E	F	G	H
Divergences	I	J	K	L

Source: Monk and Pearson, 1989.

Private profits (D) = A-(B+C), Social profits (H) = E – (F+G), Output transfers (I) = A – E, Input transfers (J) = B – F, Factor transfers (K) = C – G, Net transfers (L) = D – H or I – J – K

NPCO=A/E and NPCI=B/F, EPC= (A-B)/ (E-F), DRC=G/ (E-F) and SCB= (F+G)/E, Profitability coefficient (PC) = (A-B-C)/ (E-F-G) or D/H

### **Necessary data for different parameters of PAM**

PAM calculation required a comprehensive data set. For PAM construction, primary information are yields, inputs, market and social prices of inputs and outputs. For the study, data were collected from various national and international published and unpublished sources. Primary data on cost and return of milk production were collected from different agro-ecological zones of the country. Output and input coefficients are physical quantities of output and input. These output and input coefficients assume constant over the year under the study period. Here we compiled all the output and input coefficients are on per lactation period. We use the farm gate price as a financial or private price, which is paid by the farmers for purchasing their necessary inputs and price taken from the selling of their output. The input such as human labour, feed (dry roughages, green fodder, concentrate), medicine, vitamin, and vaccine, farm gate prices was collected from field level primary data. Farmers use both cash-purchased and family-owned inputs, and all are valued at market prices. In particular, for valuing both families and hired labour the similar wage rates have been used in this study. Inputs are divided into two categories; a) Tradable inputs: medicine, vitamin, vaccine, semen considered as 100% tradable inputs. b) Non-tradable inputs: The domestic resources include labour, land, feed treated as non-tradable inputs. Social prices are calculated on the basis of import parity prices considering commodity tradability status. However, we use the import parity price for output to know the comparative advantage under the import situation. For tradable input the semen, medicine, we use import parity price as they are imported. For estimating the parity price of this tradable output and input, we use CIF or FOB price as a world market or border price. We collect the CIF price of powder milk (port Izmir, Turkey) and the official exchange rate from World Bank. For social valuation of output under the importable hypothesis, we use import parity price. So, the social value of output is quantity multiplied by the import parity price of milk. In case of tradable input, we use import parity price for social valuation. Likewise, the social value of the tradable input is imported parity price multiplied by quantity. There has mismanagement in the exchange rate in Bangladesh. So it is necessary to estimate the shadow exchange rate to know the distortions caused by exchange rate (Shahabuddin *et al.*, 2002; Shilpi, 1998). In our case shadow exchange rate (SER) calculated from the official exchange rate (OER) by using a social conversion factor (SCF). In our study we assume milk; the output is importable as well as exportable and the inputs mainly the semen and medicine are under importable hypothesis.

So, cost, insurance and freight (CIF) and fee on board (FOB) prices are the import and export parity prices at the border respectively. These prices are used as reference prices. By using shadow exchange rate, these border or reference price converted to domestic currency than it called social border price. These entire parity prices measured at the farm gate level. The import and export parity price at farm gate level computed from the border parity price by adjusting the social cost associated with moving the imported commodity from border to the farm-gate or moving the export commodity from the farm gate to the border. For determining the parity price at the farm gate level, the border price adjusted with the marketing, transportation and processing cost. This adjustment depends on the assumption of producing areas of the output and marketing level (please sees Timmer, Falcon, and Pearson, 1983). In our study, Dhaka is taken as a wholesale market because most of the milk marketing, import and export routed and centered through Dhaka. We assume these cost the same as private and social as these are competitive price and cost. In case of powder, milk to convert FOB price to CIF price at Chittagong port done by adding the freight cost to the FOB price of powder milk.

### **3. Result of policy analysis matrix**

The results of the policy analysis matrix as well as the coefficients derived from the policy analysis matrix under import parity condition discussed with utmost emphasis.

#### **Policy analysis matrix under the import parity price of milk**

To find out the government policy incentives situation and to evaluate these policies, the policy analysis matrix is very much helpful. In Table 1, we see the tradable and non-tradable input costs at the private price are BDT 23594 and BDT 36949 per lactation, respectively. On the other hand, at a social price, the subsequent costs are BDT 24232 and BDT 40004, respectively. The private profit per lactation period of fresh milk (raw milk) production is BDT 43094 which is greater than zero (0) which indicate the supernormal returns and possible to expand milk production in future unless the per lactation milk production cannot be increased or substitutions

are more profitable at a private price. This also indicates that existing input and output prices, technologies, and government policies lead to the profitable milk production in Bangladesh. On the other hand, social profit of milk production is BDT 7108 per lactation which is also greater than zero. This value points out that milk production under free trade will be in favour of producers compare to existing situations. Thus, Bangladesh has a static comparative advantage of domestic milk production for import substitution, and it uses scarce resources efficiently.

The table also shows different policy transfer or divergences such as output, input, factor and net policy transfers. It is evident that output transfer (the difference between private revenue and social revenue) is 32292. The value is positive which indicates that government protective policies affect positively to the producer incentives. The input transfer (the difference between the private and social price of tradable inputs) is -638 which is also negative. The negative value illustrates that the domestic producer buys the imported inputs less than the world price for milk production. Thus the government has implemented input subsidy policy to the livestock sector to decrease the cost of production. Therefore the producer receives input subsidies for milk production in Bangladesh. The factor transfer (the difference between the private and social price of non-tradable inputs) is -3055 which is negative. The negative value shows the opportunity costs of non-tradable inputs are higher than their market prices. On the other hand, the net policy transfers (the difference between private and social profit or social revenue minus the social cost of tradable and not tradable inputs) is 35986 which is positive. This positive value means that milk producer could earn less profit (or high loss) without government intervention. That means under free trade producer will make less profit contrast to the existing policy situation. It can be concluded that milk producers earn a high profit under current government policy orientation.

**Table 1: Policy analysis matrix for fresh milk (cross-bred) per lactation period**

Items	Revenue	Costs		Profit
		Tradable inputs	Domestic factors	
Private prices	103638	23594	36949	43094
Social prices	71345	24232	40004	7108
Divergences	32293	-638	-3055	35986

Source: Own estimation

In the study NPCO value under import, parity was found to be greater than one ( $>1$ ) for fresh milk (cross-bred). This indicates that policies of fresh milk provide nominal protection for the producers. NPCI's values were found to be less than 1 ( $<1$ ) for fresh milk of import parity price suggesting that the government policy are marginally reducing import cost and average market price of input just keeping the world price. NPCI values of less than 1 ( $<1$ ) clearly indicate that government has been providing marginal support to the milk sector.

In addition, the study also estimated EPC (Effective protection coefficient) which is a better indicator of an effective incentive than the then NPC, as it finds the impact of production on inputs and outputs, and depicts the degree of protection according to the value addition process in the production activity. The values of EPC were found to be greater than 1 ( $EPC > 1$ ) for fresh milk (cross-bred), implying that government policies provide positive incentives to the produces.

The result of DRC calculation has been done on import parity prices. These depend actually on the tradability status on the commodity. The value of the DRC estimation revealed that Bangladesh had a comparative advantage for import substitution of fresh milk as on DRC values were less than 1 ( $<1$ ). In other words, government policy could save foreign exchange by producing fresh milk domestically and efficiently, and it causes import subsidies. This is because the opportunity cost of domestic resources and non- traded inputs used in producing milk is less than ( $<$ ) foreign exchange saved. The SCB (social cost-benefit) in less than one, it indicates that the benefit of the government policy of protection is the higher than the cost of protection. Estimated profitability is greater than 1 ( $>1$ ) indicates that the private profit is higher than the social profit. The policy benefits are in favour of producers (Table 2).

**Table 2: Different indicators of protection and comparative advantage**

Items	Unit	Value
NPCO = Nominal Protection co-efficient (subsidies to output)	Ratio	1.45
NPCI = Nominal Protection co-efficient (subsidies to inputs level)	Ratio	0.97
EPC = Effective protection co-efficient	Ratio	1.70
DRC = Domestic Resource Cost	Ratio	0.84
SCB = Social Cost Benefit	Ratio	0.90
PC = Profitability co-efficient	Ratio	6.06

Source: Own estimation

#### 4. Conclusions

The private profit per lactation period of fresh milk production was calculated BDT 43094 which is greater than zero (0) indicates the supernormal returns and possible expansion of milk production in future unless the per lactation milk production cannot be increased or substitutions are more profitable at a private price. This also indicates that existing input and output prices, technologies, and government policies lead to the profitable milk production in Bangladesh. Rearing dairy cattle, no doubt is a profitable enterprise, and the country has a comparative advantage over milk importation. From the light of research findings the following policy recommendations were made:

- The government should increase subsidy on tradeable and non-tradeable inputs to encourage milk production domestically. Inputs that are associated with dairy cattle rearing and livestock development should be kept at subsidised price so that farmers can able to purchase the required inputs easily and will make their enterprise profitable and sustainable. For dairy cattle development government import high yielding or milk producing cattle semen such as Holstein Friesian, Norwegian Red Cattle, and Guernsey, etc. from abroad. This semen is highly expensive, and the government will make it possible to purchase by farmers at a low price.
- GOs-NGOs along with other organizations should come forward to invest more in R&D and to boost up livestock sector in developing high yielding milk breeds. Research is a pre-condition for developing a new breed for better production performance. Only research can do sustainable development and production. For this, a huge amount of investment is needed, government and other national and international organizations can play a pivotal role in budget accumulation and investment.
- Pay attention to milk market stabilization through establishing mini milk processing plant throughout the country which would be a sustainable development approach in the milk sector. Through this research, we noticed that lack of preservation and marketing, farmers were demonstrating by pouring milk in a high way. Because they didn't get their remunerative price of milk. They have no facility for storing the milk. As we know that milk is a highly perishable commodity. In this regard, pasteurization and other forms of value addition can make it feasible for the proper price.

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