Assessing the Impact of Dairy Policies on Farm-Level Profits in Dairy Farms in Bangladesh: Benchmarking for Rural Livelihoods Improvement Policy

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Abstract: The objective of this study was to benchmark the set of dairy supporting policies on farm level profit in small-scale dairy farmers and also analyse how improved dairy support services and adoption of technologies enhance rural livelihoods. This study applies the International Farm Comparison Network (IFCN) method. The data were analysed by utilizing the extended version of TIPI-CAL (Technology Impact Policy Impact Calculations) model (TIPI-CAL software version 5.1). The improved dairy support services: marketing access (IM-MKS), veterinary services (IM-VHS), feeding and nutritional services (IM-FNS), community based fodder production system (CB-FPS), national breeding programme (NL-BRP) showed the highest impact on milk yield, entrepreneur's profit and household income in all three production systems compared with its base line farms. The extensive and traditional systems were responding more to the proposed policies to increase the entrepreneur's profits compared with intensive production systems. Adoption of policy increases the daily household income above the absolute poverty line (1US$/day). This study results could be useful for prioritizing the policies on delivery of support services and technology and are expected to be helpful as a benchmark to implement the 'draft policy proposal' by the Ministry of Fisheries and Livestock (MOFL) in Bangladesh.

Keywords: Benchmark, dairy policies, farm profit, rural livelihoods, typical farm.

INTRODUCTION

South Asia is the largest milk producing region in the world which is characterized by the dominance of smallholders (Haque 2009). In Bangaldesh, more than 70% of the dairy farmers are smallholders and contribute 70-80 % of the country's total milk production. Their efficiency as integrated smallholder production system provides financial, employment, health, nutrition and social benefits to millions of rural dwellers (FAO, 2010). Therefore, dairy development be seen as a strong tool to increase income to fight against the rural poverty and partially meet dietary requirement (e.g. food security) in Bangladesh.

The increased demand for milk and milk products because of burgeoning population growth, rapid urbanisation and rise in absolute income are considered an opportunity for increasing market demand for the small-scale dairy farmers (Delgado *et al*. 1999; Ahuja and Redmond, 2004). To exploit these opportunities, small-scale dairy farmers need to be more competitive by reducing the costs of milk production and thus increasing the profitability (Ndambi *et al*. 2009a). In addition, small-scale farmers need to be linked to the high-value market to gain significant higher economic benefits from the value-added products. But, small-scale dairy farmers are facing multi-faceted problems: limited knowledge and skill; lack of access to market information; inefficient links between smallholders and market, lack of extension services, lack of inputs and technology, absence of a conducive policies targeting small-scale farmers and lack of favourable institutional framework (e.g. formal contract between producers and input suppliers and processor; stakeholder's interaction, etc.) (Birthal *et al*. 2007; Shamsuddin *et al*. 2007; IAEA 2010). Adequate policy support might play an important role to strengthen their market linkages in order to bring the smallholders in line with larger farmers for reduction of costs and profit by providing mechanisms to address those problems toward enhancement of production. The development of dairy industry, thus, depends on the ability of the small-scale farmers to improve their production system, on appropriate policies, and on the rate of technology adoption at farm level. To tackle such complexities in farming system and its

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development, research is necessary that focus not only on productivity but also consider the production environement confronted by the farmers. This requires the use of a holistic appraoch (e.g. policy, technology adoption, institutions and farmers' participation) for dairy development because variations between cultures and economic circumstances define local options for further development of smallholder dairying (Falvey and Chantalakhana 2001).

However, it is also important to be aware and to understand how such constraints can be addressed in order to devise mechanisms for eliminating the problems. Dairy development strategies entails detail studies about the dairy chain, for instance how the institutional and organizational, and policy elements are linked with the process of development. Buidling a supportive policy framework and related infrastructure development bears large potentials for altering existing constraints (Ahuja and Redmond 2004). The suitable policy framework also enhances the mechanism to increase output from livestock and its consumption (ADB, 2001; Staal, 2004; Jabbar *et al*. 2010). Hence, the dairy development policy and its impact at farm level have emerged as the key concern in Bangladesh since 1992. The government strategy in 1993 to offer incentives[1] to the dairy farmers increased the country's milk production from 1.49 milllion tonnes in 1993-94 to 1.62 million tonnes (an increase of 9 %) in 1997-98 (Saadullah, 2001). Despite of this, until 2009, the government is not able to materialize a policy framework which was drafted in 1995 and proposed for temporary approval in 2005.

Finally, realizing the importance of the policy framework to exploit opportunities for meeting the increasing demand, very recently, the Government of the Peoples' Republic of Bangladesh has again taken an initiative to amend the draft policy of 1995 for livestock development by the Ministry of Fisheries and Livestock (MOFL) termed as "National Livestock Development Policy (NLDP)" and provisionally approved in 2010 (MOFL, 2007; Jabbar *et al*. 2010). This includes livestock support services and distrubution of technologies (fodder production, breeding improvement, establishment of Dairy Development Board (DDB) and Dairy Research Center). Adequate understanding to select best policies and/or technical support services is mandatory to improve dairy production while maintaining minimum investment (Ndambi *et al*. 2009a). For selection of these policies and support services, appropriate analytical tools must be developed and applied especially in the typical Bangladesh agricultural systems where farming systems are very complex and highly integrated.

Nevertheless, it is necessary to understand that adoption of policy related technologies is influenced by the typical behaviour of adopters as defined by Rogers (1983)[2]. Because without adopting new policy or technology, the expected benefit would not be reached. But due to lack of knowledge, dairy farmers are always sceptic in adopting new technologies unless a visual benefit from adopting that technology is realized. This implies that technology adoption is only possible if the farmers realize the advantages of those technologies in terms of relative utility (Batz *et al*. 1999). The quantification of the impact of policy and technology at farm level has a tremendous benefit for priority setting in policy implementation processes for improvement of milk production and farming systems.

Therefore, the research is necessary to forecast the impact of new technology and aspects of the technology adoption for the improvement of dairy sectors. Literature reviews show that policy analysis research in Bangladesh has been strongly biased to the crop sectors (Tarrant 1982; Alam and Van Huylenbroeck, 2007; Ashraf, 2008). The exception is Jabbar *et al*. (2005) who conducted a dairy farm level efficiency study to argue the importantance policy factors to overall improvement in efficiency and profit. Jabbar *et al*. (2010) also showed that the policy has become a barrier to develop an efficient dairy value chain and country's dairy development. Studies on benchmarking the dairy policy on farm level proift and household income to combate poverty seem to be missing. This study, therefore, aims to benchmark the impact of selected dairy policies and technologies on improvement of profit at farm level in small-scale dairy farms in different dairy production systems in Bangladesh. Special attention was drawn to focus on improvement of household income and farmers' livelihood status.

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[1]Under the provision of incentives mechanism, the dairy farmer who produces at least 15 liters milk per day or has 5 cows has been getting cash support of 15000 BDT per year (78.61 BDT = 1 US$ average 2011; source www.oanda.com).

[2]Rogers classified five different categories of the adopters in technology adoption process. These groups are: 1) innovators, 2) early adopters, 3) early majority, 4) late majority, and 5) laggards.

MATERIALS AND METHODS

Choice of Policy Approaches

There are several methods and approaches available for analyzing the impact of agricultural policy on farm level. Most of the methods are based upon the principles that apply to developed countries. The replication of those methods in the developing countries, like, Bangladesh, would be problematic due to distinct differences of dairy production systems, (e.g. complexity of the production environment and different production environment). The applications of particular tools are solely determined by the country to be analysed (Ndambi *et al*. 2009a). In this case, TIPI-CAL model is suit for analyzing dairy development policy in Bangladesh because it was built and validated for global application. The TIPI-CAL model has been applied in three prominent areas: the **Baseline** approach, where the impact of a single policy is analysed on one typical farm type over a period 10 years; the **Static** approach, where the impacts of several policies on several farm types are compared for a single year; and the **Dynamic** approach, where several policies are studied on one typical farm type for ten years (Ndambi *et al*. 2009a). This study uses the concept of **Static** approach (SA) because this study analyses several policies in several typical farms in a single year.

Method of Analysis

This study applies the method developed by the International Farm Comparison Network (IFCN) which utilizes 'Typical Farm Approach (TFA)' and Technology Impact Policy Impact Calculations (TIPI-CAL) model developed by Hemme (2000). This method has been refined since 2000 to suit its applicability on an international scale. The use of TFA in agricultural research is not new rather it has a century long history. The concept of typical farm was first used by Elliot in 1928 and thereafter a number of scientists replicate (Elliot 1928; Dillon and Skold 1992). The United States Department of Agriculture (USDA) uses the typical farm approach in analyzing farm economics. Recently the typical farm concept is applying by the Agriculture and Food Policy Centre of Texas A & M University (AFPC) in order to quantify the alternative policies on representative farms in USA (AFPC 2010). The TIPI-CAL model is developed based on the model similar to FLIPSIM (Farm Level Income and Policy Simulation Model) model used by the University of Texas and A&M.

The unique feature of the IFCN method is that it uses few typical farms but can ensures reliable and accurate data (Ndambi *et al*. 2008) because the selection of typical farms is done based on the opinion of the experts, farmers, researchers and local stakeholders. This method is beneficial in a complex dairy production system with scarce resources and limited data (Ndambi and Hemme 2009). This is because of its strong scientific basis, capability to have access to data on all existing costs; transparency in analysis and comparability in international scale in the arena of agricultural production cost and produce results which are closer to the reality than statistical averages (Isermeyer *et al*. 2003; Hemme *et al*. 2004; Holzner 2004). However, regarding policy analysis, there is a limitation that it is not possible to analyze the composite effect of different policies on one single farm and single parameter in a single year. Nevertheless, this method is able to answers the following questions (Hagemann *et al*. 2011):

1) What are the technical features of the farming system and production technology?

2) Which is the level of production costs?

3) What are the reasons for advantages and disadvantages in competitiveness?

4) What is the future perspectives of agricultural production at the location consider with policy implication?

The IFCN method comprises several logical procedures to secure farm level data, its analysis, interpretation and validation of the results. The INP (Input sheet) which is used for data collection comprises more than 250 variables covering general information of the farm, dairy enterprise data, whole farm data (e.g. crops and off-farm etc.), detail household data, detail costs and return data including opportunity costs for the own land, labour and capital, etc[3]. The data collection and analysis consist of the following logical procedures described below:

Formation of Panel

A panel was built for each region and each production system, comprising of three farmers, one

[3]The more detail description on the TIPI-CAL model and Typical Farm Approach (TFA) is found in the study done by Uddin *et al.* (2010b). The present study also applies all the calculations, assumptions and principles as described by Uddin *et al*. (2010a)

national dairy expert, one regional dairy expert, one representative from the Ministry of Fisheries and Livestock (District Livestock Officer), and one external dairy researcher. The panel was involved in the selection of typical farms, development of policy scenarios, data collection and validation of data and results.

Selection of Typical Farms

The selection of typical farm is done in several steps where in each step a 'Panel of Expert' come together with the local dairy expert, other stakeholders, researchers and dairy farmers to select typical farm that represents the whole dairy farms in the study areas. The steps involved in selection of typical farms are mentioned below:

Step 1

Based on literature review and national statistics, the prominent dairy regions were selected based on average milk production, type of breeds, management indices and intensity of labour use. In this study, three different regions: Dinajpur, Sirajgonj and Kishorgonj which also represent three major dairy production systems, such as, extensive, intensive and traditional were selected. Those regions and production system differs each other by production system environment (milk production, institutional arrangement) and bio-physical characteristics (rainfall, temperature, soil structure). This pre-specification of potential dairy region and probable size of typical farm was again compared in the field level by using 'Transect Study' and 'Spatial Map Distribution study'[4]. This step helps to pre-specify the dairy regions and probable size of typical farms.

Step 2

Within a pre-specified dairy region and a typical farm were then consulted with the local expert and farmers only (without experts) by organising a formal discussion in order to understand the region and farming systems using holistic approach.

Step 3

The full panel comes together and discuss on pre-specified dairy regions and selection of typical farms. After adjusting the corrections raised by the previous two steps, the typical farm is selected.

Utilizing the above described process the typical farms were selected from the north and north-eastern part of the country belonging to three administrative districts: Dinajpur (DP), Sirajgonj (SG) and Kishorgonj (KG), which also represent extensive, intensive and traditional system, respectively.The selected districts and production systems represent specific socio-economic, climate, production environment and institutional differences. The northern and north-eastern parts of the country are considered the prominent dairy regions because nearly half of milk adding to the supply chain is obtained from this region. This is due to good availability of fodder, the soil condition, multiple dairy development programmes, availability of high yielding local breeds and low opportunity cost of family labour (Hemme *et al*. 2004).

Data Collection from the Typical Farms (Base Farms or "Status quo")

The data were collected in two phases. In **first phase**, the data were collected from the typical farms (**Status quo**) based on *a priori* information (Uddin *et al*. 2010). In the **second phase**, data were collected from 30 sample farms by applying policy scenarios (described below). The general features of selected typical farms are depicted in Table **1**.

Development of Policy Scenarios on Technology and Services

After collecting data from the baseline farms (*status quo*), the following policy scenarios were developed according to the guidelines of the provisionally approved NLDP. All inputs and output data for the proposed policy scenarios were built and validated based on the Panel member's opinion, farmer's knowledge and the baseline farms (*status quo*). The five categories of policies (including management, technology and services) were developed and applied in the field study, described below:

Feeding Management

Policy Scenario (PS) 1

CB-FPS (Community-based fodder production systems): This scenario assumes that efforts taken by the Department of Livestock Services (DLS) under the Ministry of Fisheries and Livestock (MOFL) to augment green fodder production is helpful only when the participation of the community in the fodder production

[4]Transect study: transect study means to conduct informal surveys without any pre-designed questionnaire to ask the farmers randomly about herd size, milk yield, management practices, feeding systems, etc. in order to pre-assess the dairy production systems. Spatial Map Distribution Study: This means to draw a map by the researchers on the basis of personal experiences or by using secondary data to identify how dairy farms are distributed in the study areas.

Table 1: General Description of the Typical Farms in Three Regions in Small-Scale Dairy Farmers

Farm description	Unit	Farming systems		
Typical farm name		BD-2DP	BD-4SG	BD-2KG
Farming systems	text	Small-scale extensive	Small- scale intensive	Small- scale traditional
Cows number	no.	2	4	2
Breed	text	Local	PMC and cross bred with Holstein and Jersey	Local
Milk yield	kg ECM/cow/year	721	1408	741
Land base	ha/animal	0.25	0.06	0.13
Labour input	LU	1.03	2.10	1.36

LU = Labour Unit (1 LU = 2100 hours).
The number associated with the code indicates the number of cows.
PMC = Pabna Milking Cows.
Source: Uddin *et al*. (2010).

system is ensured. Improved fodder production is associated with higher milk production (Shamsuddin *et al*. 2007). The farmers prefer more to grow rice than fodder although production of fodder has higher return than cereals and helpful to improve dairy production (Akbar and Jahiruddin, 2010). Therefore, if all of the community farmers at least allocate 15 % of their land to cultivate fodder, the panellists assume that milk production will increase by up to 25 %. It will also save 30% of the purchased concentrate costs. Due to allocation of land for fodder production, farms obtain 2000 BDT[5] less from cash crops (e.g. rice).

PS 2

KW-IMG (Knowledge on improvement feed management): The farmers have poor knowledge on management. Provision of policy to improve the existing knowledge on management enhances milk yield up to 10 % and decrease feed wastage up to 20 %. Due to reduction of feed wastage, the farms save 17 % purchased feed costs. To adopt this policy, the farmers require additional 20 man-hours per year per cow to attend training and in campaign of extension services.

PS-3

PR-UFL (Promotion to use fallow land): This policy assumes to utilize fallow land to grow green grass that increase the fodder stock by 50 % and decreases the pressure on concentrate feeds purchases. This means that upon application of this policy, the farms gain 25% more milk and reduction in purchased feed costs up to 25 %. Use of fallow land requires additional 5000 BDT (Bangladesh Taka)/ha for irrigation, seeds, and labour.

PS 4

TE-UMS (Technology to use urea-molasses straw): About 90 % of the forage used in the farms is rice straw (very poor in energy and protein with high fibre). The low quality rice straw can be improved by urea and molasses treatment. The farmers require 60 additional man-hours per month to mix, store and feed urea-treated straw to the lactating animals. Due to an improved nutritional balance, animals have a higher energy intake with increase digestibility and milk yield increases up to 10 %. The feed cost decrease up to 10 %.

Animal Health Management

PS 5

CB-VCL (Community-based veterinary clinic): The establishment of community-based veterinary clinic will strengthen the veterinary network to make treatment facilities available close to the farmer's door. This will decrease the transaction costs (i.e. time, money and transportation) for securing the veterinary surgeon and farmers will be able to get timely diagnosis and treatment for their dairy cattle. The panellists assume that the proposed action will decrease the mortality rate by 10 % and improves the overall herd health status. This is associated with additional milk yield by up to 15 % and save transportation cost of 750 BDT and 20 man-hours per month. The farmers need to pay approximately 5 % of the total veterinary costs to get access these services.

[5] 1 € equivalent to 90.4519 BDT based on average currency conversion from February 2010 to February 2011 (source: www.oanda.com).

Animal Breeding Management

PS 6

NL-BRP (National livestock breeding programme): Policy on development of a breeding programme will enhances the genetic improvement of the dairy cattle by preventing the haphazard and unplanned breeding leading towards decreased productivity of dairy cattle. Planed mating under this programme will increase the efficiency of replacement and culling rate and *via* this policy; cost of the replacing dairy cow will decrease. The farmers get easy access to buy graded cows. The panellists assume that the proposed policy will decrease the transaction costs (labour, transportation) for securing graded cows by 20 % and increase milk yield up to 25 %. To obtain a graded cow the farmers have to bear 50 % higher procurement cost, feed cost +25 % and breeding cost and simultaneously veterinary cost +25 %, capital cost +30 %, and machinery cost 1000 BDT per year.

Dairy Development Programmes

PS 7

ES-COP (Establishment of cooperatives): This policy is proposed to replicate Bangladesh Milk Producers' Cooperatives Union Ltd. (Milk Vita) model to other potential areas. The establishment of cooperatives ensures a secured access to milk markets with additional benefits (as premium) of 100 BDT per 100 kg milk. Cooperatives also provide veterinary health care services with minimal fees, artificial insemination services, extension and training services at lower cost rates. Milk yield increases up to 20 % while overall veterinary cost will decrease 30 %, artificial insemination cost up to 75 % and feed cost by 15%. The farmers have to buy a share of 500 BDT to be member of the cooperative.

Delivery of Improved Dairy Support Services

PS 8

IM-VHS (Improved veterinary health care services): The delivery of improved veterinary services is the policy of the Ministry of Fisheries and Livestock to prevent the herd from diseases in order to keep sound herd health for increasing milk production. While doing so, the cost of such delivery is taken into consideration and the decision is to provide improved services with cost recovery mechanisms. The packages of improved veterinary services include regular vaccinations, periodic diagnosis, home visit by the veterinary surgeon upon request, and disease prevention. This policy is assumed to have positive impact on improved herd status, which subsequently increase milk yield, by about 30 %. Due to improved quality of milk, the farmers get a premium on price about 200 BDT per 100 kg milk. The farmers can save treatment cost by about 40% and decrease labour input by 30 %. The farmers have to pay 600 BDT per month to access these services.

PS 9

IM-MKS (Improved marketing services): The improved marketing service package involves services to increase effectiveness of the input market (i.e. feeds, other basic requirement for fodder production), market regulation for the support services and output market (i.e. milk). The consulting services on how to market milk without wastage and with relatively higher prices will also be provided. This policy assumes a reduction of concentrate feed prices by about 20% due to policy intervention on effective delivery of feeds, and decreases the cost for fodder production by about 15 %. The milk would be sold with 20 % higher prices and decrease labour input in milk marketing up to 20 %. The farmers need to pay for services about 250 BDT per month.

PS 10

IM-FNS (Improved animal feeding and nutrition services): Upon delivery of improved feeding and nutrition services enhances knowledge on the adoption of a precise feeding strategy on balanced ration formulation. This also helps to provide adequate diet for different age, lactation period, frequency of providing ration, provision of adequate drinking water and hygienic precautions. This policy assumes that farmers increases milk yield by about 15 % without any additional feed inputs because of the provision of balanced ration. The feed cost decrease by 30 % due to improved feeding system and the appropriate dietary management can increase the quality of milk due to which farmers get a premium on milk price by 200 BDT per 100 kg milk. This also saves labour input by 30 %. The farmers require additional 175 BDT per month to get access to this service.

After the initial field survey and implementation of the policy scenarios, a second field survey was conducted to investigate the actual outcome of the policy activities on farm performance. The farmers were asked to quantify whether dairy supporting policies and technology adoption on the farm level would have any impact once those are implemented.

Variables to Measure

Four key indicators were selected to analyse the impact of dairy policies: milk yield (Kg ECM/cow/year), return to labour (US-$/hour), farm's entrepreneur's profit (US-$/100 kg ECM), and household income (US-$/day).

Milk Yield

The **Milk yield** is measured as the differences between total amount of milk produced per farm per year for base farms (farms without policy) and case farms (farms with policy). This was selected as an indicator for identifying the potential ways for improvement in milk production because milk is the major output which determines the profit the dairy farms. The milk yield is calculated as kg Energy Corrected Milk (ECM)[6] per year by converting litres of milk per cow per lactation to kg of milk per year.

Return to Labour

Return to labour was selected to measure the local competitiveness of dairying by measuring the economic output of every hour of labour input compared to average rate in those particular areas. This is important because farmers who have alternative employment opportunities can deicide as to whether they continue working on their farms, hire external labour, or to cease dairy production altogether. The return to labour for the dairy enterprise was obtained by dividing the total returns from the dairy by the total number of hours per year spent on dairy farm, as shown by equation 1

$$RL = \frac{RM + RL + RB}{h} \qquad (1)$$

where, **RL** is the return to labour, **RM** is the return from milk sales, **RL** is the return from sale of livestock (male calves, heifers, etc.), **RB** is the return from beef sales, and h is the total number of hours spent on the dairy farm per year.

Entrepreneur's Profit

The **Farm Entrepreneur's profit was** selected as the financial benefit of being involving in dairy production. This also indicates the cash flow of the farms. The farm entrepreneur's profit is calculated as below:

$$FEP = TR - TC \qquad (2)$$

FEP is the farm entrepreneur's profit, **TR** is the total return and **TC** is the total costs. The **TR** is calculated as

$$TR = (rm + rl + rma + gp) \qquad (3)$$

Where, **rm** is the return from milk sale,**rl** is the return from other livestock (e.g. male calves, beef cattle, culled cows, etc), **rma** is the return from manure and **gp** comprises government payments. The TC is calculated as below:

$$TC = vd + fd + pw + lr + il + op + \delta V + \delta H + \delta K \qquad (4)$$

where, **vd** is the variable cost for dairy; **fd** is the fixed cost for dairy; **pw** includes all paid wages on the farm; **lr** is paid land rent; **il** consists of paid interests on liabilities; **op** is the opportunitiy costs for own land, labour and capital; **δV** is the depreciation costs for building and machinery; **δH** represents changes in inventory; and **δK** comprises capital gains/losses.

Substitution the TR and TC into the equation 2 yields

$$EP = (rm + rl + rma + gp) - (vd + fd + pw + lr + il + op + \delta V + \delta H + \delta K) \qquad (5)$$

Household Income

The farm **household income** (HI) was selected as indicator of the rural livelihoods and poverty status. The HI is calculated by the following functional form

$$HI = FP_d + FP_c + OI \qquad (6)$$

where, **HI** is the total household income, $\mathbf{FP_d}$ is the profit from dairy, $\mathbf{FP_c}$ is the profit from crop, and **OI** is the off-farm income. The $\mathbf{FP_d}$ is calculated from equation 5 and the FP_c is calculated by subtracting all the costs related to crop production from the revenue for crop production and adjusting the non-cash components (depreciation for machinery and building, inventory changes).

Data Analysis

All data were analyzed by using TIPI-CAL software extended version of 5.1 (Hemme, 2000). Data were entered into the model as base farms ('*status quo*') and the case farms (with policy) for each of the production systems. Each production systems consists of one

[6]Energy Corrected Milk (ECM) is calculated based on the use of correction factors for fat% and protein% using the following formula: ECM = Milk production (kg) / ((0.383* fat% +0.242 * protein% + 0.7832)/3.1138) (IDF 2003). The milk production in liters was converted to kg by using factor of 1.033 (liters of milk*1.033).

base line farm and 10 case farms (11 farms for each production system; therefore, n = 33) were entered into the model and were analyzed.

RESULTS AND DISCUSSION

Milk Yield

The impact of dairy policies on milk production has been depicted in Figure **1**. The delivery of improved veterinary services (IM-VHS) showed the highest impact on increasing milk yield by about 23 % in intensive and traditional dairy production system. On the other hand, the policies on community participation in fodder production (CB-FPS) and national livestock breeding programme (NL-BRP) have the highest (20%) impact in extensive production system.

The improving knowledge (KN-IMG) and TE-UMS have lowest impact in extensive and traditional production systems. This might be due to the fact that improving knowledge meaning the general knowledge which does not help technical knowledge on management of dairying. This general knowledge without having access to support services is not beneficial. The other reason could be that use of urea molasses straw (UMS) needs more labour inputs and specific training on how to use it. The danger of using UMS is that once intake exceeds than the recommended level it will have adverse effect on productivity.

The positive impact of the dairy supporting policies in this study are comparable with the study done by Olhan *et al*. (2010) who also found an increase of milk yield by 32.06 % as a result of implementation of livestock support policies on farm levels. An increased milk yield might bring the opportunity for farm household to increase household consumption of milk (especially for the children) which improves the household health status, and increase sales. Correlation coefficient of 55, 60 and 62 % between milk yield and household income were obtained for extensive, intensive and traditional production systems, respectively, implying that provision of supporting policies on milk yield is also beneficial for improving the household income as milk yield is directly related to cash income (Conroy 2005). This indicates that adoption of technology and support services on farm level have potential to increase milk productivity but it is

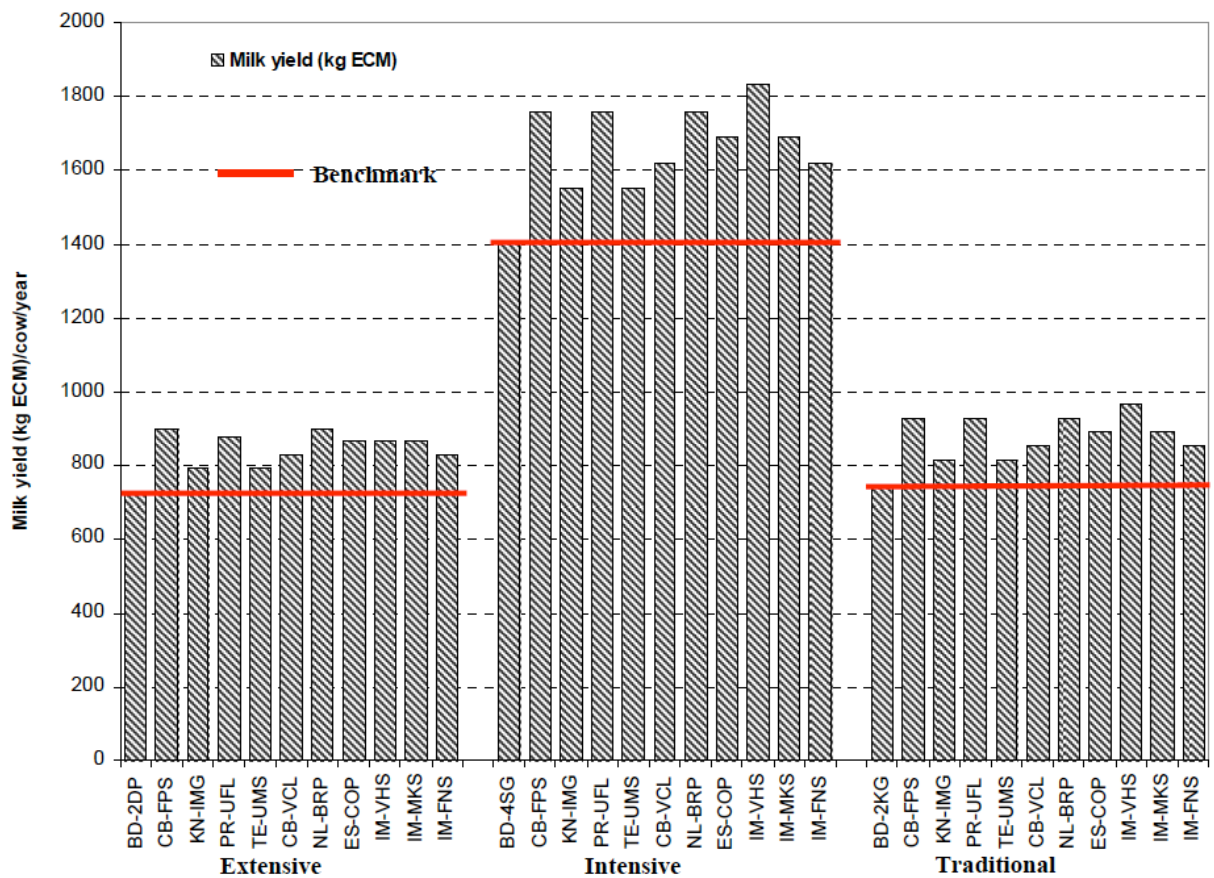

Figure 1: Policy impacts on milk yield in different dairy production systems.

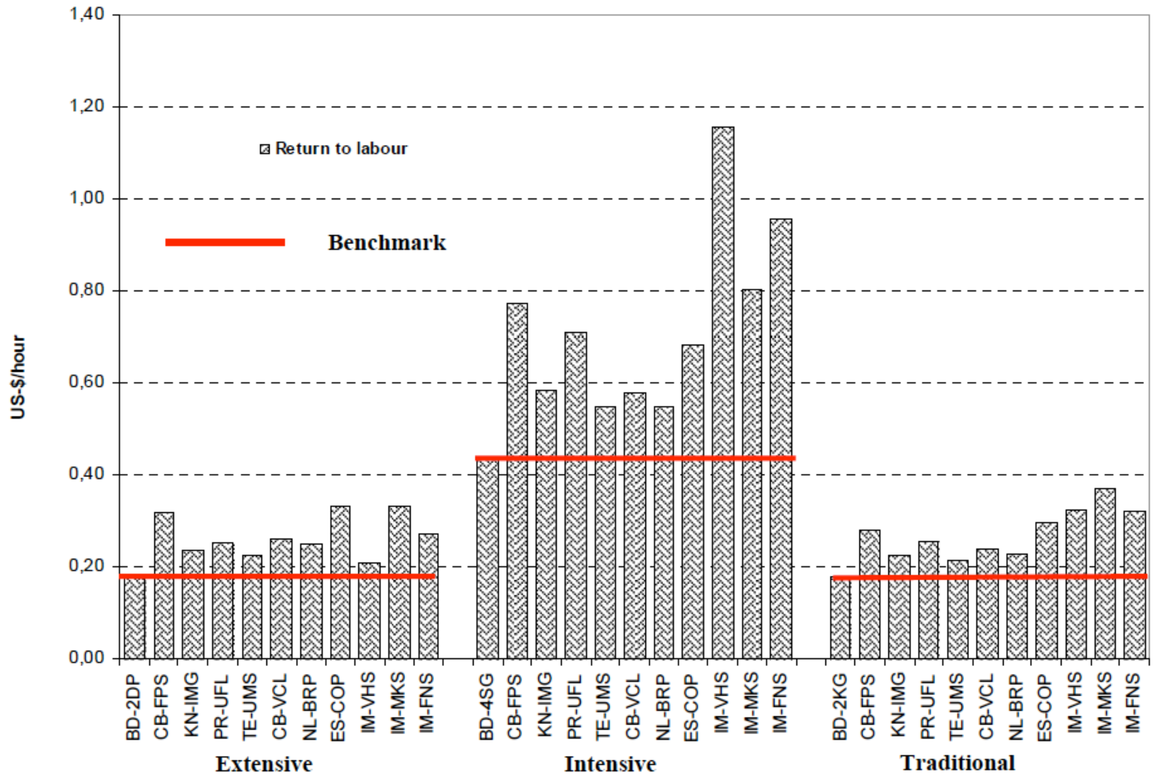

Figure 2: Policy impacts on return to labour on typical farms in different dairy production systems.

highly influenced by the adopters' characteristics (Khanal *et al*. 2010).

Return to Labour (RL)

The average RL in base line farms from extensive, intensive and traditional production systems are 0.18, 0.43 and 0.18 US$/hr, respectively which is lower than average wage rate in the regions for extensive and traditional production systems (Figure **2**). Application of policy and technology at farm level are assumed to substantially improve RL with the highest increase about 63 % is observed for IM-VHS in intensive production system while, that is 52% for IM-MKS in traditional production system and 45% for ES-COP and IM-MKS in extensive system. Similarly TE-UMS also have lowest impact on extensive and traditional production systems.

The link between labour productivity and off-farm income plays a strong role in sustainable dairy production system (van Calker *et al*. 2005) indicating imminent intervention to ameliorate toward more productivity in dairying. Otherwise, lower RL might be a threat for economic sustainability of dairy production as it is found in milk production sector in the Netherlands. So, the dairy polices, especially increasing market access, can have profound role to increase RL and thus prevent labour migration from dairying to other sector. This is more important for extensive and traditional production systems. Simultaneously, opportunity for off-farm jobs might be a crucial point to implement policies to increase RL as it is found that farmers having lower RL would shift to other sector (Ndambi *et al*. 2009a). The opportunity costs for labour, therefore, influence the dairy development pattern in developing country (Staal *et al*. 2008).

Entrepreneur's Profit

The impacts of dairy policies on the farm level profit measured as entrepreneur's profit of typical dairy farms from different dairy production systems are depicted in Figure **3**. All of the intervention policies have a positive impact on increasing entrepreneur's profit. The most substantial impact is observed for IM-MKS with changes from -0.93 to +10.19 and -0.27 to 14.40 US-$/100 kg milk ECM for extensive and traditional production systems, respectively. The IM-VHS shows the highest impact on increasing farm profit from 9.33 US-$ to 27.79 US-$ per 100 kg ECM in intensive production system.

Except for the intensive production system, the technology on poor quality forage improvement (TE-UMS) shows the lowest impact on increasing

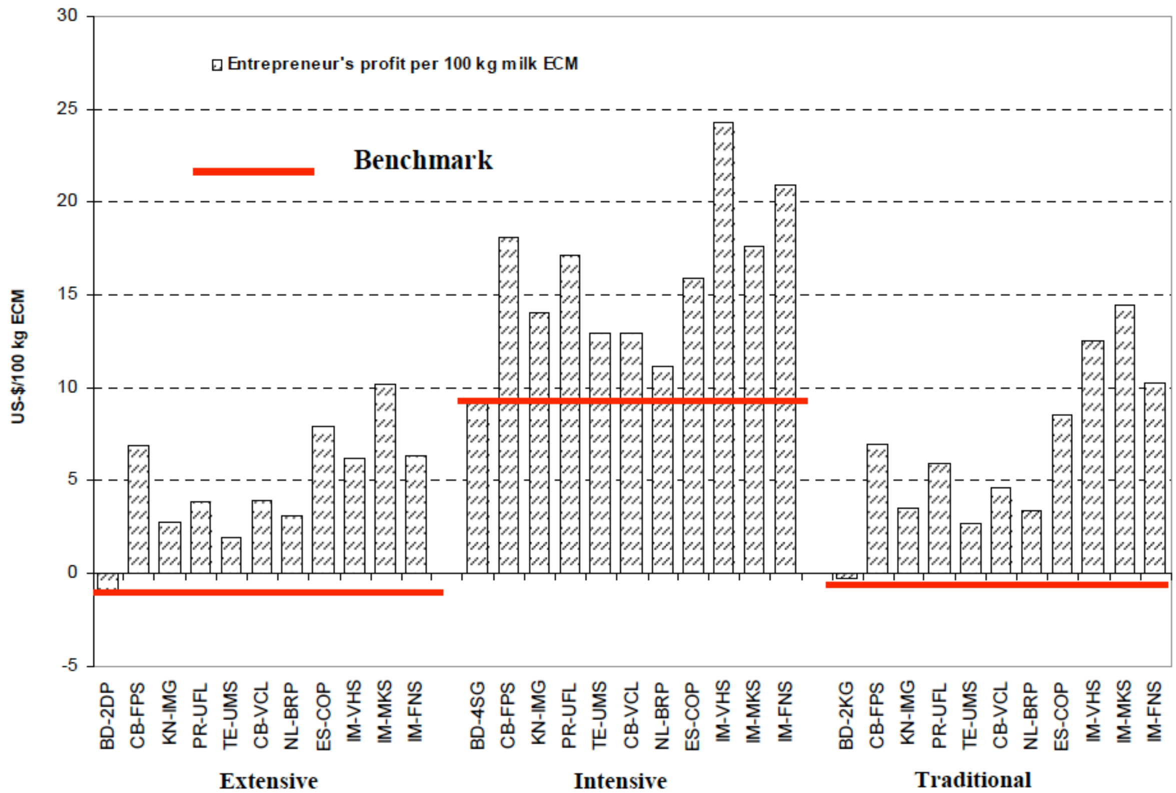

Figure 3: Policy impacts on farm-level profits in different dairy production systems.

entrepreneur's profit because the intensive farms mostly offer concentrates to cows and gain milk yield substantially. The policy related to the national livestock breeding programme showed the lowest impact in intensive production systems. This reflects the reality, because the intensive dairy farmers are already using mostly graded and high yielding cows (Islam *et al*. 2010), and benefit less from the introduction of breeding programme to facilitate graded cows. The impact of IM-FNS policy gives mixed results. While this policy showed a second highest impact for intensive and traditional production systems the similar impact level as with IM-VHS was observed in extensive production.

The profitability of the dairy farming is one of the important criteria to understand the future viability of the farm, because profitability is associated with economic sustainability of dairying (van Calker *et al*. 2005). The existing socio-economic situation with increasing globalization effect compels the dairy farmers in developing countries to be profit-oriented. Thus, policies focusing on increasing profit might be adopted faster on farm level as it is found in Khanal *et al*. (2010). Farmers with negative profit margin are not able to cover the full economic costs and as a result drive away the farmers from dairying, which is a threat for economic sustainability of dairy production The results obtained from assessing policy impacts indicate that the farmers benefit from investing in own land, family labour and capital can enhance the dairy production.

Household Income

Among 10 policies analyzed in our study, more than half (six) of the policies (CB-FPS, TE-UMS, ES-COP, IM-VHS, IM-MKS and IM-FNS) are able to increase the daily household income upto or above the poverty line (Figure **4**). The improved market access generate the highest increase in daily income from 0.48 to 1.40 US-$ (66%) and from 0.54 to 1.46 US-$ (63%) for extensive and intensive production systems, respectively. In traditional production system, the IM-VHS policy showed the highest impact from 0.56 to 1.19 US-$ (53%) per day. Interesting to note, ES-COP showed the highest impact in traditional production system meaning that the government draft policy to replicate the existing cooperative model (MOA 2006; MOFL 2007) into other disadvantageous areas is a worthwhile decision.

The policy related to improved veterinary (IM-VHS) and nutrition services (IM-FNS) have a similar trend

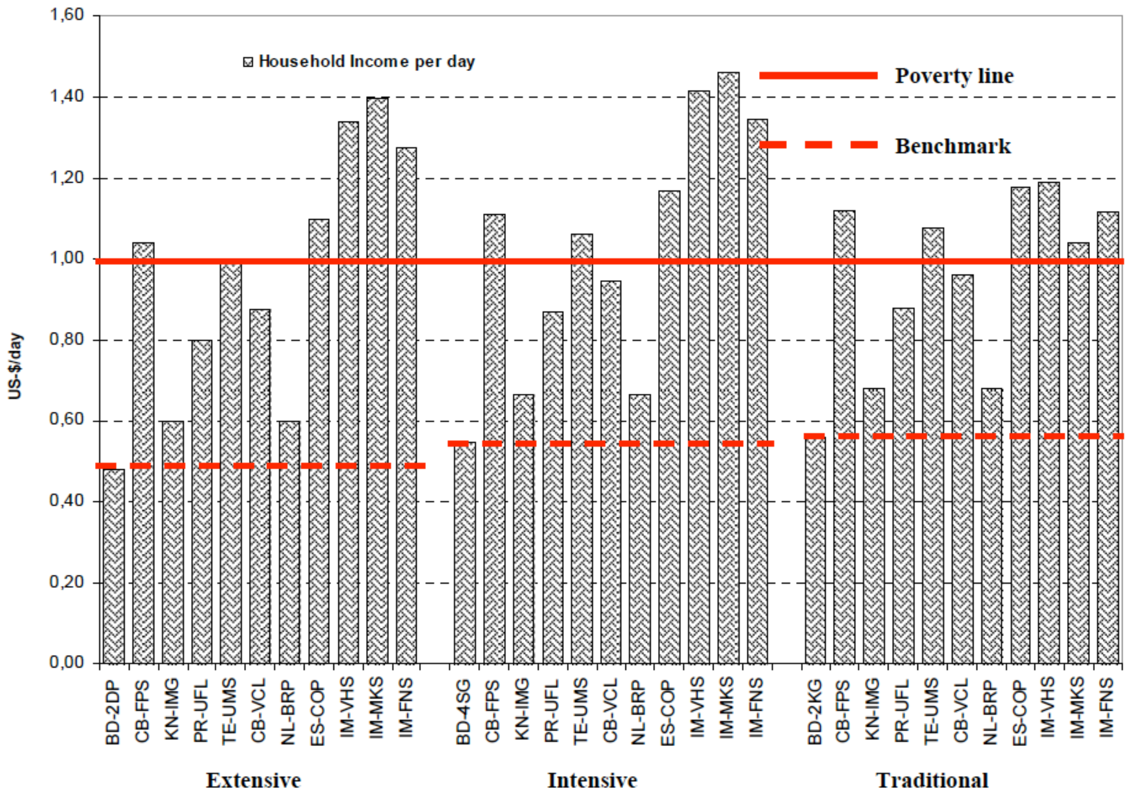

Figure 4: Policy impacts on household income in different dairy production systems.

among all the production system. As the traditional production system has less access to veterinary services, the policy can play a vital role to increase income and thus reduce the poverty. The lowest household income is assumed for knowledge improvement policy (KN-IMG) and NL-BRP in all three production system. The former policy impact might be explained that farmers not only need knowledge but also need material and support services. The low assumed impact of NL-BRP is probably related to the high initial capital costs and high risk of maintaining high-yielding cross bred cows under low input systems. To improve the effectiveness of NL-BRP, the policy should favour this technology by ensuring provision of complementary supports that reduce risk (e.g. veterinary services, feed input, credit and marketing access).

The household income model (equation 6) indicates that off-farm income plays a vital role in determining the household income. Even though, the limited alternative jobs and low average wage rates (Figure **2**) implies that without dairy only off-farm income is not enough for survival by farm families. Simultaneously it also reveals that dairy has the potential to increase income for poor once the supporting policies are identified, prioritized and implemented on farm level (FAO, 2010).

The rural livelihood improvement has the objective to uplift the income level to at least 1 US-$ per day[7] (ADB, 2001). Policy without targeting the livelihoods of the farmers have adverse effects on rural livelihoods as it is found in Hemme and Uddin (2009) who found that an increase of export subsidy by 5€ per 100kg Skimmed Milk Powder (SMP) adversely affect the livelihoods of 7 million farmers in Bangladesh and 0.45 million farmers in Germany. Therefore, policy that favours to increase household income per day bears tremendous significance to reduce rural poverty and it might be well accepted by the farm community and donor agencies.

Implication for the Design of Sustainable Poverty Reduction Strategy Locally and Internationally

The livestock sub-sector (e.g. dairy) has emerged as an important source of gainful employment and income for the vast majority of the rural poor with a good probability to improve livelihood and alleviate poverty (FAO, 2010). Lack of a suitable policy framework is considered as a potential barrier for

[7]The poverty line is called International poverty line defined according to Millennium Development Goal objectives of having an income of at least 1 USD per day.

improvement of the dairy value chain (Jabbar *et al*. 2010), which drives the dairy farmers far below the international competitive level. Providing a conducive policy framework can increase the level of farm profit and the livelihoods of dairy farmers as shown by Hemme and Uddin (2009).

This requires the development of national policies targeting small-scale producers to have similar access to technologies and support services which might be helpful for economic, social and political development as it is observed in the case of participation of women and development in Benin by improving productivity and efficiency (Kinkinginhoun-medagebe *et al*. 2010).

The major objective of the NLDP is also to increase the self-sufficiency by reducing imports and promoting local production (Jabbar *et al*. 2010) which requires a substantial increase in milk production. Results from this study provide a clear view where emphasis should be given. The delivery of IM-VHS might be associated with improving herd health status. Because preventive veterinary care, regular vaccination, early disease diagnostic significantly decrease the prevalence of both contagious and infectious disease and increase average herd productivity and efficiency (Zibaei *et al*. 2008).

IM-MKS is found to be a potential way to increase market access by linking small-scale farmers to the high-valued market in order to gain substantial economic benefit from value-added products (Birthal *et al*. 2007). But the existing market infrastructure for feed and milk in rural areas (e.g. extensive and traditional production systems) are under developed and are not in an acceptable form as perceived by the farmers, which prevent farmers to sell their milk in a regular way. Moreover, the small-scale farmers are apprehended with incomplete and asymmetric market information, shortage of technology and access to marketing services (Ahuja and Redmond, 2004; Birthal *et al*. 2007). Nevertheless, majority of the small-scale farmers are highly linked with the informal market which heavily depends on personal relationships and trust. Development of local markets, thus, strengthens the link between farmers and consumers, and reinforces the economic sustainability (Sassenrath *et al*. 2010) indicating the importance of the priority for improving market access. The potential ways to do this is to strengthen institutional capacity, such as, implementation of formal contracts and establishment of farmers' groups. Similarly, establishment of cooperatives is also worthwhile in order to increase productivity and farm profit (Birthal *et al*. 2007).

Enhancing fodder production and utilization of indigenous feed resources (e.g. use of by-products) in a participatory way (CB-FPS) significantly increase milk yield in different regions in Bangladesh and have a positive impact on the environment. Since extensive production systems use partial grazing, it requires provision of adequate green fodder which need to be produced either on own land or on community land. The farmer's attitude toward participation in community programmes for green fodder production reveals that their priority is to allocate land for cereal production rather for production of green fodder, though economic analysis showed that production of fodder provides higher return per unit of production than crops (Akbar and Jahiruddin, 2010). Community programmes on relay cropping (e.g. leguminous fodder with rice) might be a solution for expanding fodder production.

Similarly, policies on technologies (NL-BRP) to alter genetic merit of the local cows and to enhance milk production has a high priority, especially for the extensive farmers because this farming system uses mostly local cows with higher willingness to upgrade their breeding stock. The use of artificial insemination (AI) might be straight forward to disseminate the improved genetic merit to the local cows and enhance productivity (Vishwanath, 2003). That's why dissemination of superior genetic material is the most important activities in a genetic improvement programme (van Arendonk and Bijma, 2003).

The institutional capacity (monitoring, compliance with service standard) to improve breeding services is not fully utilized and there is further scope to improve on efficiency in delivery of AI (IAEA, 2004). The national breeding programme might also focus on the selection of animal based on their estimated breeding values (EBV) for improving the breeding objective traits. While designing a breeding programme, attention should be paid to consider the limitation of environmental, infrastructural and socio-economic conditions of farming systems. Sustainable breeding programme should include "what is possible" and "what is optimal" (van der Werf, 2000) which implies that producers can have a choice to decide on the improvement of existing dairy cattle based on their production objectives and ability to pay for improved breeding programmes.

The study results showed that improvement of veterinary services, milk market and nutrition services play a profound role in improving the farmer's profits and increase household income. It should be taken into consideration that those technology and service related policies will only be adopted once farmers perceived it as advantageous and cost effective for their farming systems. The adoption of new technology (e.g. improved services and fodder production) is highly influenced by the relative utility of the new technology, initial costs and its payback period (Batz *et al*. 1999). The results obtained from this study are quite helpful to the process of priority setting by the development organizations while designing policy and technology packages for improvement of dairy production in the country' poverty reduction strategy.

CONCLUSION

Results of this study indicate the important role of dairy policies and technology to improve overall dairy sector. Improved veterinary services (IM-VHS), access to improved factor and product markets (IM-MKS) and provision of quality nutritional services (IM-FNS) are effective to bring a loss-making dairying into a profit-earning dairying, especially in extensive and traditional production systems. The technology such as, increasing fodder production through a community system (CB-FPS) and implication of AI through NL-BRP substantially increase farm profitability and household income. Establishment of cooperative improves labour productivity in extensive production systems and household income in traditional production systems.

Comparing the impact of policies on production systems reveal that extensive and traditional production systems are more receptive toward policies because these two production systems are operating with disadvantageous farming environment and with lowest farm income. Therefore, adopting new policy and technology would provide more utility as it is in line with the classical utility theory. In addition, the extensive and traditional farming systems are dominated by marginal farmers, which are the centre of poverty reduction focus. Nevertheless, these findings could be used as benchmark in order to design strategy for prioritizing policy and technology adoptions on farm level for further development of dairy sector. The five key policy and technology were identified as being particularly important in terms of their overall impact as a benchmark on the proposed dairy policies in Bangladesh, such as:

i) The improvement of dairy support services to facilitate access to veterinary (IM-VHS), marketing (IM-MKS) and feeding and nutrition services (IM-FNS)

ii) The establishment or replication of dairy cooperatives, and

iii) Technology related policies to improve the fodder production (CB-FPS) and breeding improvement (NL-BRP).

Thus, these policy implications might be worthwhile to use in line with the government's poverty reduction strategy. The future policies are expected to utilize these findings in designing and priority setting for a sustainable technology and services package for overall improvement in dairy production systems. Concurrently, this requires conducting further research on benchmarking medium and large-scale farmers and inclusion of broader perspectives of farming systems as well as also necessary to take into account the impact of technology and policy on the improvement of technical efficiency.

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