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Technology Transfer in Agro-Based Industry of Bangladesh: Opportunities, Challenges and Options

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----------ABSTRACT----------
Agriculture in the twenty-first century is reinventing itself as a new global business reshaped by globalization, standardization, high-value production, massive growth in demand (both for the food and the bio-fuel industries), retail and packaging innovations, and a ramp up in effectiveness. Faced with constant productivity and market pressures, the "new agriculture" needs new tools to improve its competitiveness and innovation power. One of these tools is the promotion of technology-based processing. Though Bangladesh has improved in agro productivity but agricultural industry is lacking in proper post-harvest management, lack of effective policies, lack of technologies and modern concepts. If proper attention is given utilizing the new technology and concepts the industry will boom soon which ultimately will contribute to national economy. In coming days, the Bangladesh Readymade Garments is going to face increased competitiveness in global market thus she should find alternative approach to compete global market. Considering potentialities Bangladesh may try to improve the agro marketing system with the help of modern technology and concept. The present study investigates some futuristic strategies and policies that the country can evolve and implement on the basis of ground realities in the agricultural sector of Bangladesh. While doing so Government should evolve and implement a viable policy.

Keywords*: Technology, Agro-based Industry, Opportunities, Challenges and Global market.*

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I. Introduction

Now a day's agriculture routinely uses modern technologies such as robots, temperature and moisture sensors, aerial images and GPS technology. These progressed devices and precision agriculture system allow businesses to be more benefitable safer and more environmentally friendly. Technology transfer is the procedure of sharing of skills, knowledge, technologies, methods of manufacturing, samples of manufacturing and facilities among industries, universities, governments and other institutions to ensure that scientific and technological developments are accessible to a wider range of users who can then further develop and exploit the technology into new products, processes, applications, materials or services [1]. Technology Transfer can only be said to be efficient when the recipient (organization or individual) is capable of regularly using and applying it as part of trade – it has become part of the principles in the broadest sense.

Though the productivity has improved in agricultural sector but due to poor management and processing in post-harvest have hindered in self-sufficiency in food. It has been found that 30% of the horticulture product spoiled or damaged due to poor post-harvest management and processing which ultimately put negative impact the agro-based industry. If the modern technologies and concepts are adopted in post-harvest management and handling which will help and encourage farmers and agro businessmen in agro-industry, then the problem can be solved. These eventually will have positive impact on our national economy. Considering potentialities Bangladesh may try to improve the agro marketing system with the help of modern technology, concept and cluster system. This can make our agro-based industry a profitable and export oriented. The present research investigates some innovative strategies and guidelines that the country can develop and implement on the basis of ground realities in the agricultural sector of Bangladesh. While doing so Government should evolve and implement a workable policy.

II. Research Methodology

The research is based on both secondary and primary sources. The secondary sources which were studied are: books, journals, reports, and data from various official and unofficial sources. For primary sources, information and statistics from official and unofficial sources are collected; interviews have been conducted with various shareholders including farmers. Both formal and informal interview methods have been adopted to collect qualitative information concerning various aspects of agricultural relation in Bangladesh. I have

interacted with small-scale farmers of different villages and accumulate information on post-harvest management, agro processing and marketing. Besides I have performed field survey on few agro processing and marketing companies i.e. Pran Group, Fleming Agro-Technology Limited. Both qualitative and quantitative approaches have been adopted as a methodology.

Conceptualizing Technology Transfer:

Technology transfer is the system of expertise transferring, knowledge, technologies, technique of manufacturing, models of manufacturing and facilities among governments or universities and other institutions to ensure that scientific and technological developments are reachable to a wider range of users who can then further develop and utilize the technology into new products, processes, applications, materials or services. It is almost related to (and may arguably be considered a subset of) knowledge transfer. The technological knowledge that is transferred can undertake various characteristics. It can be represented in goods (including physical goods, plant and animal organisms), services and people, and organizational arrangements, or codified in blueprints, designs, technical documents, and the content of innumerable types of training. Alternatively it can be communicated through flows of tacit knowledge i.e. knowledge that has not been fully codified, and remains embodied in the skills of people [1].

Historical Perspective: The technology transfers the basis of human civilization. It is not a new phenomenon. Technology is transferred from parents to children, between neighbors and community members from the very beginning of the human being evolution when people started to use hand tools to hunt or catch animals or to collect foods and fruits. Those are all conventional technologies transferred to the next generations in a good will. Transfer of modern technology however, is for competition and utilization. It depends on many factors and the main purpose is economic advantages. The concept of technology transfer was created in the industrial developed countries.

After Second World War many devastated countries boosted up their economic development through technology transfer and monetary assistance from United States. Later technology transfer expanded from developed countries to developing nations all over the world. Money or financial resources has been the problem for most developing countries. So the World Bank and International Monetary Fund provided them with loans to buy technology but they also imposed various conditions for economic development through their instruction. With only few exceptions the technology sold by Europe and North America to the developing nations of Africa and Asia was obsolete and often outrageously priced [2]. Cases like this are abundant in Bangladesh. For examples, the Dhaka Leather Complex was transferred by the Netherland's fund in 1990; Karnafully Fertiliser Company was established in late 1990s through private sector. After coating with paint a number of items of the old machinery, the suppliers priced the leather complex's machinery three times to four times higher than its market price. The export-import agreement signed was totally one sided. Sirolli (1995) says that even before one piece of equipment reached its new destination, all the money was back in western coffers and some of it was hiding in Swiss bank accounts. Such technology transfer does not contribute to a fair and sustainable economic development [2].

Theoretical Perspective: According to Rosenberg (1982) technology is a commodity, knowledge or a socioeconomic process. One technology can be reproduced to another technology [3]. According to this view of technology is replaced by the view of technology as knowledge [4]. Research and improvement bring this knowledge from inventions to new items, processes and services in practical use. According to Chen (1996), till the buyers understands and can utilize the technology, the technology transfer is not achieved. One of the criterions for technology transfer could be the ability of the buyers to choose and adapt the technology to the local socio-economic environment and raw materials [5]. If there is lack of such capabilities, to choose technology transfer could be inadequate, flawed, unsafe or bad. On the other hand, perhaps cheaper technology and equipment transfer can take place. The trend of public discourse does not help the understanding of technology transfer as it lumps science and technology together. Often, technology research and development leads to scientific progress, which in turn may lead to creation of more new and modern technology. Furthermore, modern technology is very much private or proprietary knowledge rather science as public knowledge [6]. Scientific knowledge is freely available to all that are scientifically literate but private/proprietary knowledge is not. Technology travels from one place to another in a variety of ways when it is treated as knowledge. Dodgson and Bessant (1996) assert that the complex ways in that knowledge travels from individual to individual and organization to organization brings up the first problem in effective technology transfer [7]. Since it is not only a patent or a piece of equipment transfer but also knowledge, process and practices, technology transfer may vary person to person.

Forms of Technology Transfer*:* The technological knowledge that is transferred can undertake various forms. It can be embodied in goods (including physical goods, plant and animal organisms), services and people, and

organizational arrangements, or codified in blueprints, designs, technical documents, and the content of innumerable types of training. Besides it can be transferred through flows of tacit knowledge – i.e. knowledge that has not been fully codified, and remains embodied in the skills of people. All these forms of knowledge may vary in a further important way. The transfer of technological knowledge can be concerned with the knowledge for using and operating technology and also it can be concerned with the knowledge necessary for modifying technology and updating.

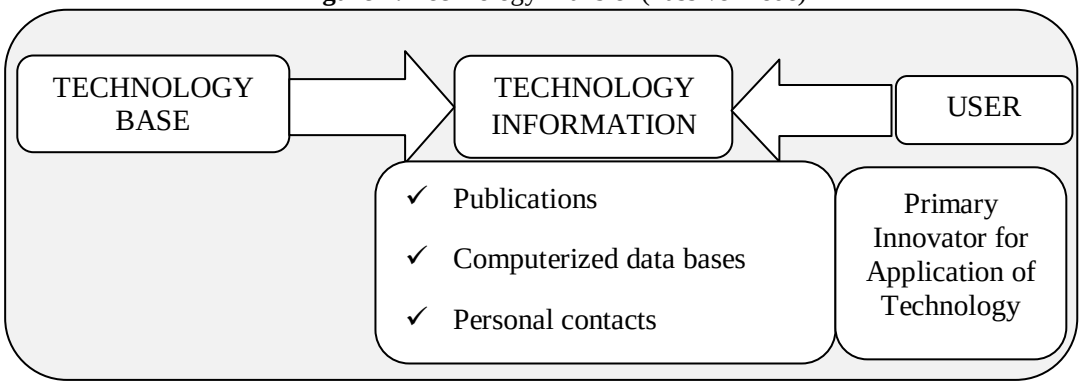
III. Dimensions of Technology Transfer

The time and resources required to transfer a given technology depends upon:

Technology Transfer Modes: Basically technology transfer is classified into passive, active and semi-active modes. Let us have a look at some examples of technology transfer modes.

Passive Mode: If the transfer methods offer the technology to the possible users without assisting them in their application, such as by a report or oral presentation, then that technology transfer is called passive. In passive mode, technology transfer is also termed as knowledge transfer. Form of passive technology transfer is illustrated in the figure 1.

Figure 1: Technology Transfer (Passive Mode)

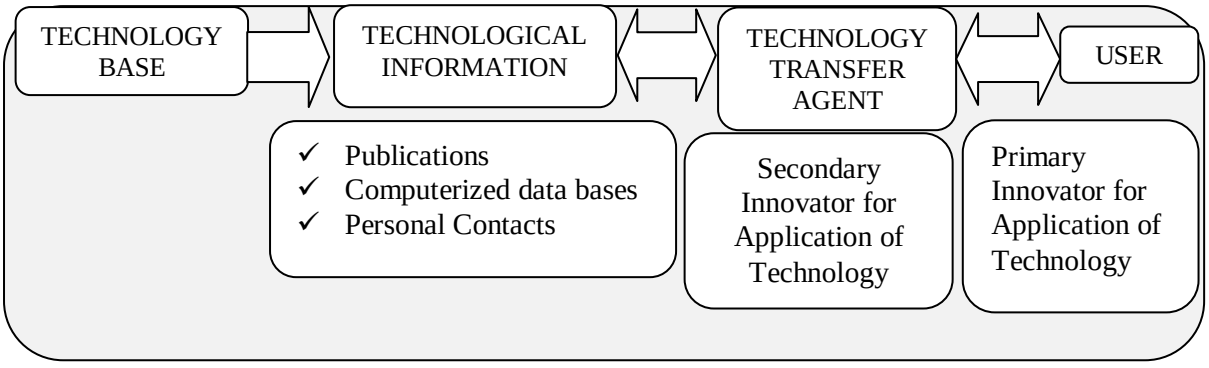


Source: Sharif 1995 [8].

As per figure above, there is no direct communication or assistance from the originator of the technology to the producer of finished consumer item. In technology transfer, thousands of commodities are produced and consumed from passive mode, that is, in the transfer of knowledge, there is no straightforward communication within the producers of technology and product. Some of the forms of passive technology transfer are television repair manuals and how-to-do-it guides or user manual for home repairs.

Semi-active Mode: In this mode of technology transfer, the function of the agent of technology transfer (in addition to self-education or self-recovery of elements of technology transfer) is somewhat limited, as illustrated in figure 2.

Figure 2: Technology Transfer (Semi-active Mode)

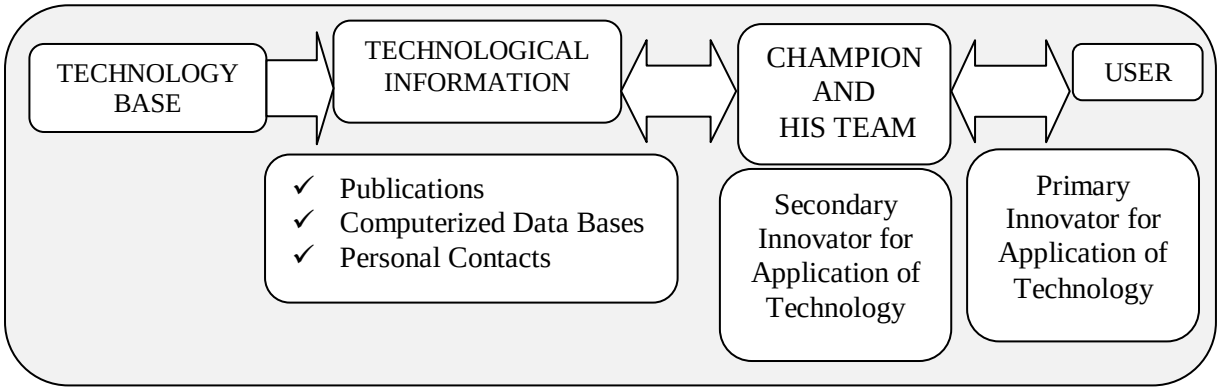


Source: Sharif 1995 [8].

The technology transfer agent (consultant or technology expert) screens available pertinent information for product development. Here the function of transfer agent is only to interpret or communicate. He will not actively get involved in the application of the technology.

Active Mode: The active mode of technology transfer takes forward the procedure to a genuine form. In this mode, the technology transfer agent or consultant will be fully involved and acts as a bridge in technology transfer from technology producer to entrepreneur or implementing agency (Figure 3).

Figure 3: Technology Transfer (Active Mode)



Source: Sharif 1995 [8].

Horizontal and Vertical Technology Transfer: In horizontal technology transfer, the technology transfer is from one firm to another. The horizontal transfers are done normally between the firms in various countries, mainly because of the competition and development or near advancement of technologies. In vertical technology, the technology transfer is done, from an R&D organization to a firm. The vertical transfers are done mainly inside the country and the recent technologies may frequently need extra efforts in terms of setting up commercial viability. Such a transfer has huge risk.

Let us have a look at some technology bases, along with their technology transfer modes, and relevant users or needs, in table 1.

Table 1: Connecting Technology with Users

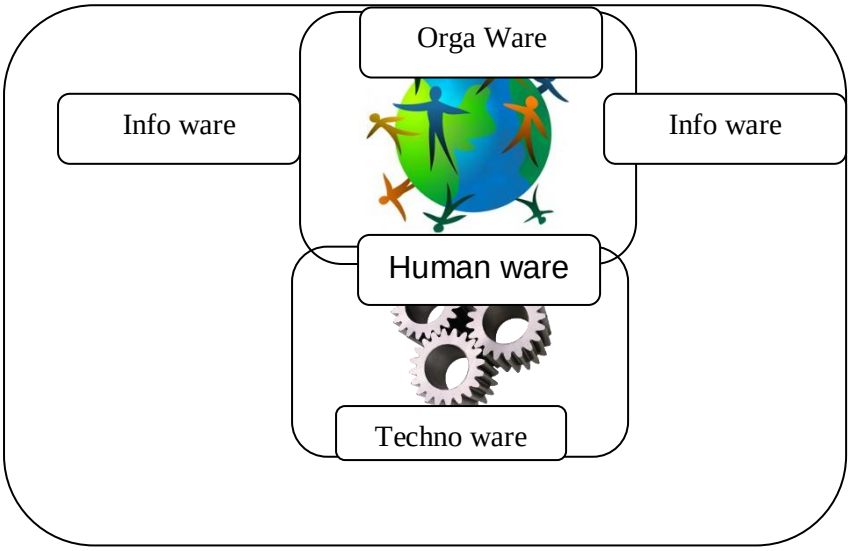
TECHNOLOGY BASE	**TECHNOLOGY TRANSFER MODES**	**USERS / NEEDS**
Engineering	Passive	Traffic Safety Emergency Health Care
Communications	Passive or Semi-active	Crime Prevention
Medicine Electronics	(Passive or Active)	Public Transportation Drinking Water Quality
TECHNOLOGY BASE	**TECHNOLOGY TRANSFER MODES**	**USERS / NEEDS**
Energy	Active	Energy Conservation Urban Construction so on.
Structures	Semi – active	Private Sector
Chemicals Materials Computers so on.	Active	Industry Agriculture, Mining Consumer Products, Automotive Medicine so on

Source: Amin 2005

Technology Transfer Mechanisms:

The mechanisms in technology transfer are the ways of transmitting the technology available with the seller to the buyer. Considering the fact that technology in a comprehensive sense comprises of four components namely, "hardware" (materials such as a variety), "software" (technique, know-how, information), human ware (human ability), "orgaware" (organizational, management aspects) with varying degrees of sophistication, it is hardly surprising that there are many mechanisms for transferring technology. Relationship of technology components is at figure 4. As developing countries have lower levels of technological capability than developed countries, it is possible that the range of mechanisms which are used for developed and developing country transfers are greater than in the case of developed country transfers.

Figure 4: Relationship of Technology Components



Source: Sharif 1995

Many writers classify the various mechanisms of technology transfer under different names such as direct and indirect mechanisms, contractual and non-contractual mechanisms, market oriented and development oriented mechanisms. Ramanathan (1995) classifies the technology transfer mechanisms as market oriented and non-market oriented [9]. Market oriented mechanisms are those introduced only with a profit motive as a basis where market forces become critical in determining the growth, competitiveness and profitability of both seller and buyer. On the other hand, non-market oriented mechanisms are used to indicate that such mechanisms are not mostly motivated by market forces and economic considerations. Such examples are exhibitions, Expos, free materials.

Bangladesh may take on market oriented mechanism of direct foreign investment, joint ventures, technical collaborations, technical services agreements and joint research venture. In non- market oriented mechanisms, she may adopt industrial fairs and exhibitions, participation in conferences, seminars and workshops and training.

IV. Agro-based Technology Transfer in Bangladesh

Need to Improve/Increase Agro Productivity and Agro-based Industry:

The overarching goal of the Government of Bangladesh (GOB) is to achieve a 50% decrease in poverty by 2015 as per Millennium Development Goal (MDG). In addition to maintaining a sound macro-economic framework, the Poverty Reduction Strategy Paper (PRSP), entitled "Unlocking the Potential - National Strategy for Accelerated Poverty Reduction" (GOB, 2005), highlights the need for higher growth in rural areas and development of agriculture and rural non-farm economic activities.

Agricultural Productivity: Agriculture accounts for about 23% of GDP. It plays a critical role in the overall economic development of Bangladesh. The rural non-farm sector, which is driven primarily by agriculture through the backward and forward linkages, accounts for another 33% of GDP. Over time, the share of production agriculture in GDP has declined whereas the share of rural non-farm sector has increased. About 75% of Bangladesh population lives in the rural areas and their major sources of livelihoods are agriculture and the rural non-farm sector. With almost 85 out of 100 poor people living in the rural areas, poverty in Bangladesh is mostly a rural phenomenon. Hence, improvement in agricultural sector performance and acceleration in growth are critical to reduce rural poverty. This would be possible only through an increase in agricultural productivity (for crops, horticulture, livestock, fisheries and forestry) based on modern agricultural technology and a supply chain linking farmers with the consumers in the national as well as export markets.

Agro Based Industry: While poverty is still widespread, Bangladesh is almost food self-sufficient. With food needs met, demand for basic food crops is growing only slowly. But, with a rising middle-class and rapid growth in urban areas, people want more variety and higher quality foods along with processed foods. This creates great potential for farmers to earn higher incomes. They can produce more meat, fish, fruits, vegetables, dairy products, new grains and cooking oils for local consumption and more exotic products for export markets.[i]

To make the process to be successful, agribusinesses need to work with farmers and traders to encourage new crops that can be processed for the market. Bangladesh Government with donor countries/institutions should focus to support of private sector agribusinesses particularly on private business support services by improving technology to encourage new product development, improved market linkages, better food quality and development of business support institutions. Moreover, government regulatory controls make it difficult to increase production for some crops. These can be viewed as "wholesale" problems affecting a large number of firms and farmers throughout the country. Some of the donor partners emphasized business development services by concentrating at the firm level, problems were identified, solutions devised and good results achieved. Though initiative was successful but only some 300 firms and several hundred farmers and farmer groups received assistance. It was a "retail" approach that can only have a limited impact in a country with 140 million people and several hundred thousand agribusiness entities.

Role of Technology in Agriculture and Agro-based Industry:

The strategic role of agricultural technology (research and extension) derives from the critical importance of agriculture in the overall economy. Overall, investment in agricultural research and extension (a) yields high economic returns; (b) improves competitiveness of agriculture; (c) provides food security; and (d) reduces poverty. In order to achieve these goals, adequate public investment in agricultural research and extension is extremely important and should be given a very high priority.

Yields High Economic Returns:

No matter which measure of return is selected or which analytical method is applied, an extensive literature in agricultural economics credibly demonstrates that investment in agricultural research and extension yields high payoffs. Table 6 shows the real rates of return to agricultural research and extension. For public sector agricultural research, average returns were 48 percent for developed countries and 80 percent for developing countries. The rates of return to investment in agricultural research are generally very high. However, the amount of the rates of return varies from one crop to another, from one livestock product to another, from crop sector to livestock sector or aggregate agricultural production, from one country to another, and from developed to developing countries. Positive and high rates of return means that the stream of societal benefits from research outweigh the costs over a planning horizon of several years. The costs of these investments are repaid because the economy grows as a consequence of the reduced food and fiber costs that benefit both consumers and producers, the reallocation of physical and human capital into higher and better uses, and increased economic activity, including trade. But as with any investment, there is often a lag between expenditure and return. For agriculture, the lag may be 10-20 years. Even allowing for the long lag, however, the expected return on investment in agricultural research and extension is positive and high.

Table 2: Summary of empirical Studies with estimated Rates of Return to R&D

Activity/Regions	Numbers of Studies	Studies with Range of Estimates for Rates of Return (%)				
		1-24	25-49	50-75	75+	Mean
Public Sector Agricultural Research	10	2	3	3	1	41
Africa	36	14	22	13	13	46
Latin America	35	7	20	23	25	56
Asia	85	23	45	40	44	80
All developing countries	71	21	54	26	29	48
All developed countries						
Private Sector Industrial Research						
Developing countries	5	0	3			58
Developed countries	35	10	20			44
				3		
Public Sector Agricultural Extension				10	2	
					5	
Developing countries	17	4	2			50
Developed countries	6	1	0			63
				4		
				3	6	
					2	

Source: Self complied from World Bank paper no 7 on Bangladesh Development series: 2005.

Improves Competitiveness of Agriculture:

Public support for agricultural research is can also an important part of a nation's strategy to increase the competitiveness of its agricultural sector, whether through directed public investment or public action to promote private research. The meaning of operationally increased competitiveness is that the agricultural sector is much able to sell products abroad or to produce alternatives for products being imported. Increased

competitiveness is desirable because it results in improved standards of living for the given nation or region. Research attempts to ease limitations that are largely the consequence of resource endowments [10]. Agricultural research and technological development create competitive advantage by improving the ability of the agricultural sector to create importance for domestic and international consumers. The consequences of technological and managerial innovations fostered by agricultural research are sustained high rates of return and escalating market share.

Improves Food Security:

There is a global and national perspective to agricultural research that is particularly important. In a study, McCalla (1994) juxtaposes plausible growth rates in world population and income against historical growth rates in agricultural productivity [11]. What emerges is a simple disquieting fact: agricultural productivity must continue to increase worldwide at or above historical rates if future food demands are to be met without potentially dire human consequences. This biased perspective further diminishes the world's collective capability to achieve the needed increases in agricultural productivity in manner that can be continued into the future. From the national perspective, food security is extremely important to Bangladesh because of huge population, land scarcity, vulnerability due to frequent natural disasters and high levels of poverty. Agricultural research and extension plays an important role in improving productivity and increasing standards of living for rural as well as urban people.

Reduces Poverty:

There is a clear and strong link between improved agricultural technology and poverty reduction. Improved agricultural technology results in increased productivity in agriculture, reduced cost per unit of agricultural output and sustainable use of natural resources. Increased agricultural productivity accelerates pro-poor growth in agriculture (in Bangladesh, land is shrinking and increase in productivity is the only source of agricultural growth). An increase in productivity can also result in falling real price of food grains, an important wage good. Clearly, growth in agriculture is pro-poor and hence results in poverty reduction in the rural areas.

Agricultural Sub-sectors of Technology Transfer:

Poultry:

In the past poultry was not an organized sector and individual household raised chicks without proper care and preventive measures. The number of birds available in the market was limited and the number of eggs laid by birds was not more than 50 or 60 a year. Market demand was also very limited --- so there was hardly any motivation to produce more or improved quantity of chickens or eggs. The driver for the poultry industry in Bangladesh – as in many other countries – with that available technology, genetics and feed are able to produce meat and eggs at prices far below prices from traditional poultry production, and also below prices for other meats. The companies, donor projects, and NGOs of Bangladesh have been introducing poultry technology at least from the 1980s. But with the steady increase in income and rapid urbanization the demand for higher quality foods has increased sharply; growing 10-15 percent a year. The Savar area in Dhaka district became the initial center of commercial poultry production in the country but it has now spread to other areas like Chittagong, Khulna, Rangpur, Bogra and Mymensingh. Various donor countries have provided advice and offered assistance to help companies expand their sales and upgrade their technology. The poultry industry with the help of donors and NGOs is expanding rapidly and is highly successful. The positive aspects are that development and technological advice is now available through commercial channels. But the industry needs new technologies, business services, new equipment and processes to ensure quality, standard and bulk production.

Aquaculture:

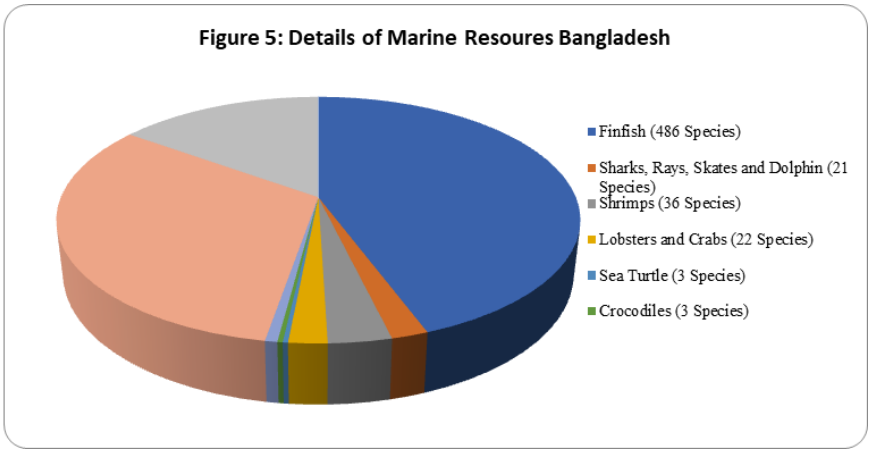
The people of Bangladesh are commonly referred to as 'Macche-Bhate Bangali' (i.e., the people made of fish and rice). Rice and fish have been an essential part of the life of Bangladeshi people from time immemorial. The staple foods of the people of Bangladesh are rice and fish. Rice is the foremost agricultural crop in Bangladesh with an annual production of over 29 million tons per annum, while annual fish production is 2.70 million tons [12, 13]. The demand for rice and fish is constantly increasing in Bangladesh with nearly three million people being added each year to the population of the country [14]. Along with marine fisheries, the large number of rivers, ponds, and flooded paddy fields provide an excellent base for catching fisheries and aquaculture. The fisheries sector contributes roughly 23 percent of agriculture GDP and 6 percent of total GDP and employs 13 million people fulltime and 12 million part-time.

Saltwater and Freshwater Shrimp:

Bangladesh is a minor player in international shrimp markets with only 2.8 percent of world shrimp exports (including 10% of the market for golda freshwater shrimp). Current shrimp exports (primarily bagda saltwater shrimp and golda freshwater shrimp) of about $300 million per year account for roughly 5 percent of total Bangladesh exports, but for a larger share of domestic value added in exports. The volume (value) of shrimp exports increased from 7.5 thousand tons ($40 million) in 1981 to 25 thousand tons ($210 million) in 1994, and to a reported 45 thousand tons presently. Bangladesh shrimp exports have traditionally been low value bulk exports (for example, frozen in a 2 kg. block), but processors have been moving up the value chain by investing in individual quick frozen equipment. European Union concerns about food safety led to a ban on shrimp imports from Bangladesh from July 1997 to February 1998. As a result, major government, industry, and donor took initiatives to introduce better quality control practices using a "Hazard Analysis at Critical Control Point" (HACCP) program. But some problems with quality have continued – for example, in December 2004, the US Food and Drug Administration (FDA) rejected some shrimp shipments. Compared to other exporters, Bangladesh has a bad reputation. To put the problem in proper perspective it would be useful to compare Bangladesh shrimp rejection rates to those of other exporting nations --- but this evaluation was unable to find hard data and heard conflicting information about the seriousness of Bangladesh's difficulties. In contrast, shrimp yields in Thailand are 2 to 3 tons per hectare, and in India they are 1 to 2 tons per hectare. Shrimp farmers in Bangladesh have not had access to technology available in neighboring countries for higher yields (including technology to manage the white spot syndrome virus (WSSV), which has attacked Bangladesh Bagda shrimp since 1995).

Marine Fisheries:

Bangladesh has a coastline 480 km long and exclusive economic zone (EEZ) is about 322 km (200 miles) seaward from the base line. The Bay of Bengal offers a potential source of fisheries for Bangladesh although most its vast resources yet remain unexplored. In the Bay, a total of 490 species of fish belonging to 133 families were recorded. Among them 65 species are of commercial importance. Due to lack of appropriate survey by competent authority the stock and resources still remains unexplored. Marine fisheries have had an important role in compensating for the reduction in catches from inland fisheries. The share of marine fisheries in total national landings has boosted from 10.6% in 1970 to 28.2% in 1993. Around 95% of marine fish production is estimated to come from artisanal fishing practiced on the extensive continental shelf. Artisanal coastal fisheries include both commercial and subsistence fishing. Most people living in coastal communities make their livelihood from fishing. On the other hand, due to overfishing, environmental and habitat degradation, and competing uses of water systems fisheries –particularly the in-shore marine and estuarine fisheries – are under stress. Bangladesh is one of the resourceful countries with its wide range of marine aquatic bio-diversities. There are about 1093 marine aquatic organisms where 44.35% are finfish, 32.23% shellfish, 15.10% seaweeds and only 8.32% are other organisms including shrimps. The details in number of species and their percentages are shown in the figure 5.

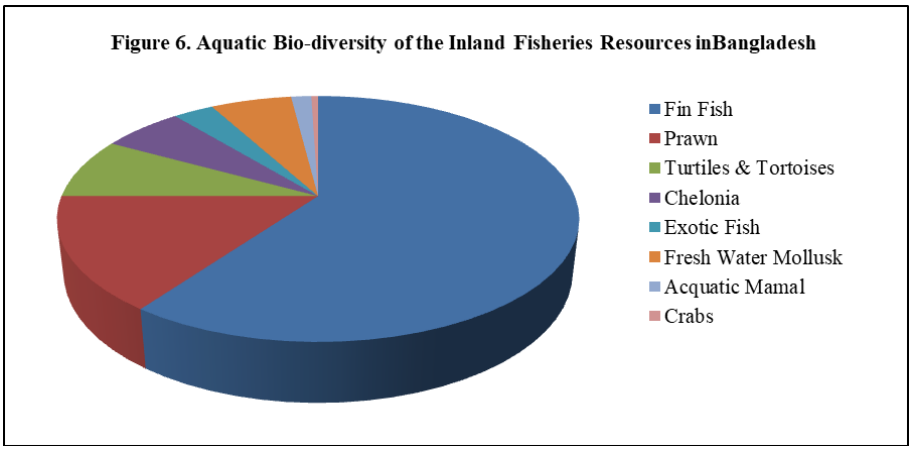


Source: Kabir 2010 [15].

Finfish:

In addition to varieties of aquatic organisms, a total of 260 indigenous freshwater bony fish species suitable for human consumption, belonging to 145 genera and 55 families (Nishat and Roy, 1992), constitutes a very rich aquatic bio-diversity (Figure 6). According to current estimates, open water (river) fisheries provide 590,000 tons, and aquaculture (fish ponds) provides almost 900,000 tons. Over 30 years (as population has

nearly doubled) fish supply per capita has increased modestly while the source of fish has shifted strongly from capture to culture fisheries. The concept of poly culture has open a new era for poor farmer, where fish and shrimp could be grown along with rice in flooded paddy fields. With proper skills a farmer can use his existing food crop fields to grow an additional and valuable cash crop. The need for supplemental feed and improved marketing linkages were a problem in this sector. The farmers need training on hygienic methods of chilling and icing fish and improved methods to transport fish fries and fingerlings. Besides, the farmer may be sponsored high-value non-traditional exports of fins, bladders, and other products. Presently, much of the fin-fish industry is small in size and hard to reach through a business services approach. Recent trend seems that freshwater shrimp cultivation and poly culture are profitable as more number of farmers are cultivating shrimp and fish. Future work on technical and production issues in aquaculture can provide high returns in the form of more intensive production and higher value products, such as larger fish. Further assistance to fish food producers could accelerate introduction of high-quality feed. In processed fish, as in horticulture, pesticide residues are an issue. A future project could work with government to set standards and with processors and traders to arrange for mechanisms to ensure compliance. Information on foreign markets, and assistance with packaging could help processors to increase export revenues and expand demand for fish production in Bangladesh. I have conducted number of case study on fisheries business by small farmers. I have found that fisheries sector has huge potentials and technology can play a big role in production and marketing capacity. Case Study 1 on one of such farmer namely Din Mohammad of Mohespur, Jhenidah is given at annex A.



Source: DoF 2010 [13].

Horticulture (fruits, vegetables and spices):

The growth in Bangladesh's population, income and rate of urbanization has propelled a shift to higher value foods. As a result, the horticultural (fruits and vegetable) component of agriculture and food consumption in Bangladesh has been growing at a higher rate. With moderate temperatures throughout the year, fresh fruits and vegetables comprise the largest share of the market; growing seasons can be extended with new varieties and cropping practices such as plastic covers and plant growth regulators. The farmers have entered new markets, introduced new products, and increased domestic and foreign sales. In fiscal year 2004, horticulture farmers increased their domestic sales to a considerable rate. Continued expansion of fresh fruit and vegetable exports – with or without agribusiness services – is constrained by air freight availability and costs. The horticultural agribusinesses face expanding domestic markets and large potential export markets, but it is uncertain what the comparative advantage might be for Bangladeshi farmers and producers. Existing agribusinesses may be expected to gradually discover and exploit many of these opportunities with or without donor-assisted business services. Opportunities for processed horticultural products for domestic markets are apparent in prices and imported (competing) products. Hence, the agribusiness advice required to assess and respond to domestic market demand for processed horticultural products may not be that great. Similarly, international fresh food markets appear to be limited by available air freight facilities. Economic and market analyses are required to determine if Bangladeshi farmers and producers could compete on the basis of international prices and qualities. Another portion of the horticultural market that may benefit from technical advice is the domestic market for fresh fruits and vegetables, where new species and varieties and new cropping practices may allow Bangladeshi farmers to deliver more fruits and vegetables to domestic fresh markets. This can help to extend growing seasons. Technologies to extend growing seasons can have an important impact on farmer incomes on the one hand and diets on the other. While new technologies may allow domestic agribusiness expansion, the required technology introduction to the farm level bureaucratically falls under

extension and agricultural research rather than agribusiness services. I have conducted number of case study on horticulture sector where I have found that post harvest management i.e. packaging is one of the challenging aspects in this sector. But these challenges can be overcome by applying technology. Case Study 2 at annex B shows how one can be successful and benefited in post harvest management of horticulture sector by utilizing science and technology.

Dairy/ Livestock:

According to conventional culture, Bangladeshis consume milk and milk products including yogurt and sweets. In recent decades, imported milk powder has provided a bulky share of the milk consumed in the urban areas and processed through large organizations (such as Milk Vita). During 1996/7-2000/1, annual milk powder imports ranged from 21,000 to 30,000 tons. Bangladesh has 6 million female cattle of all ages with average milk production of 1.25 liters per day. With these figures, domestic cows provide around 20 liters of fresh milk per person per year, while roughly 0.2 kg. of milk powder are imported per person per year. The policy obstacles and – in some cases – lack of a "dairy culture" obstructed dairy and livestock agribusinesses progress. Another limiting factor of this industry is the dominance of small family farms and small enterprises in much of the sector, while the large businesses in the sector often look to imported milk powder rather than local production. Assessing opportunities for development of the domestic dairy industry involves analysis of various producer and market segments, prices of imported subsidized and unsubsidized milk powder, opportunities for technical and organization innovations to reduce domestic costs, and attention to the range of milk products that can be marketed in Bangladesh. Given the relative importance of domestic milk production vs. imported powdered milk in Bangladeshi diets, and given as well the very low productivity from Bangladesh cows, the biggest impact on incomes and welfare may be expected from a focus on production issues – including feed and genetics. Preserving milk is one of the greatest problems. At annex C, Case Study 3 shows how a poor farmer with small fund applying technology can eliminate the preservation problem by making small chilling plant with local technology.

Post-Harvest Management: Bangladesh Perspective:

Typically, the main challenge has been to produce enough food to feed the growing population and making it accessible to people of all kinds. But in Bangladesh all the produced crops cannot reach to market place due to post harvest loss. This loss is about 30% of total production. Limited capacity for post-harvest handling and processing often undermines the profitability of farming especially during years of bumper harvest. Notably, the usable nature of many agricultural products limits their access to gainful markets thus dwindling income of small farmers. Hence, enhancing post-harvest technologies is the critical strategy to add value to the food crops so as to increase price and move millions of Bangladesh small farmers from poverty.

Present State of Post-harvest Technologies in Bangladesh:

Evidently, there is praiseworthy progress on agricultural sector in Bangladesh and there has been low pace on post-harvest technologies. There is an emergent concern that this would not only contribute to post harvest losses but also restrict small farmers to get access on niche markets. The development of post-harvest value addition has been limited despite the high potential of the food crops sub-sector. The majority of strategies so far undertaken in the whole field of post-harvest technology have been involved with grains, and other durable products which are stored dry. On the other hand efforts on perishable crops have been addressing the post-harvest and processing of fruits and vegetables and not staple foods like potatoes. Unlike strong research on crop production, the post-harvest advanced technologies have attracted low number of stakeholders despite the importance attached on it. However, the development of post-harvest technologies is seen by many as viable pro-poor development policy. The enhancement of such technologies require many partners with different caliber such as research institutions, government agencies, farmers' organizations, financial institutions, private sector, so as to improve the livelihood of smallholders. The Bangladesh's' agricultural limitations like other developing countries are eminent in market and are worsened by lack of innovative post-harvest technologies to improve quality of agricultural products. Imperatively, policies and initiatives that target to improve farming and collection systems of harvest are paramount to increase earnings of small farmers and motivate young farmers to involve in agriculture as business activity.

Opportunities of Technology Transfer in Agro-based Industry:

Agricultural Sector is the Second Largest Contributor to GDP:

Agricultural Sector is the single largest contributor to GDP after RMG sector. The RMG sector is totally import dependent whereas agricultural sector is fully self-dependent. Applying right technology and managing the same properly can boost the sector vibrantly and can contribute to GDP in accelerate rate.

Crop Production System is Highly Labor Intensive and there is an Abundance of Labor in the Country: As the crops production is highly labor intensive and there is plenty of labor in the country, the scientific use of this huge labor force can bring certain change in the productivity.

Agriculture is the Largest Source of Employment for Skilled and Unskilled Labor: Proper technological training can make the skilled and unskilled labor more proficient working in agricultural sector which will decrease unemployment problem of the country as well as discourage in urban employment opportunities. Besides, we may explore the African labor market.

Wide Range of Bio-Diversity Exists for Different Crops:

The research and development using technology has introduced the bio-diversity in different crops in Bangladesh which can help the productivity and varieties in agricultural sectors.

Different Crops and Agricultural Commodities are the Main Sources of Nutrition:

Large population of the country are suffering from malnutrition particularly children. Different crops and agricultural commodities of Bangladesh are main sources of nutrition including Protein, Minerals and Vitamins. If methodically and scientifically different crops are produced considering the nutrition value and requirement then national malnutrition can be exterminated.

Agricultural Commodities have Comparatively Higher Value Addition than Non-Agricultural Commodities:

Due to non-import dependency, cheap labor and fertile land in agro productivity contribute higher value addition than non-agricultural commodities. This can be further increased by applying technology in harvesting, post-harvest management and marketing.

Challenges for Technology Transfer in Agro-based Industry:

Sustainable intensification and diversification of agriculture through technological change requires an efficient and productive agricultural technology system comprising of agricultural research (technology generation and development) and extension (technology dissemination). This needs to be supported by appropriate value addition and market linkages.

Agricultural Research:

The National Agricultural Research System (NARS) was successful in increasing cereal yields over the last 30 years when production more than doubled. However, the system devoted limited resources to research on horticulture, fisheries and livestock sub-sectors and to research on post-harvest management and agro-processing needs. Furthermore, in more recent years, the research output has declined and average yields of crops, milk, meat and fish have remained low with a large gap between what research produces and what farmers want as well as between farmer yields and the research station yields. An important challenge facing the NARS, therefore, is to increase farm incomes through higher agricultural productivity from an intensively used and a declining land resource.

Agricultural Extension:

Since 1982, the Department of Agricultural Extension (DAE), under the Ministry of Agriculture (MOA), has played its part in transferring crop technologies that led to an increase in cereal yields. In addition, the Department of Fisheries (DOF) and Directorate of Livestock Service (DLS) and other also maintain extension service. DAE (crop extension) invests the largest amounts of public funds on extension. By comparison, extension expenditure of the Department of Fisheries (DOF) and the Directorate of Livestock Services (DLS) was much smaller. Of the total DAE budget, only about 15% was allocated to operational costs of the extension. The remainder was used to finance salaries of about 24000 staff (of which 16724 are field staff). This leaves the public crop extension system with a chronic shortage of operating funds limiting contacts with farmers and affecting both the quality and quantity of service. In addition, inter-departmental coordination among DAE, DOF and DLS remains weak; staff skill development has not kept pace with demands of the participatory processes; and linkages with research need further strengthening. Transfer of appropriate technologies to farmers under "contract" with agro-processing enterprises is an emerging need offering opportunities for mutually beneficial public-private partnerships.

Concept of Agricultural Modernization:

Agricultural modernization is synonymous with the application of engineering technologies in agriculture. The concept of mechanized farming is not fully understood and practiced in the agricultural sector in this country. Mechanization has always played the supporting role in agricultural development. In future days, only those crops that can be highly and effectively mechanized will be able to service and sustain in the highly competitive local and global environment.

Shrinking Agricultural Land:

Agricultural land is an important natural resource. In Bangladesh cropped land is declining at the rate of about 1% per year. On an average, Bangladesh is losing good quality agricultural land by approximately 80,000 ha annually due to urbanization, building of new infrastructure such as roads and implementation of other development projects. This issue needs to be addressed by formulating and implementing a new national land use policy that stops and/or slows down the rate of decline in agricultural land. In addition, the quality of agricultural land has also been deteriorating over time. Agriculture has to expand into the problem lands that have inherent constrains to the application of agricultural engineering technologies.

Limited Diversification and Low Value Addition:

There is also a substantial scope to increase agricultural production by reducing post-harvest losses, by increasing the shelf life of perishable commodities and by adding value through agro-processing of agricultural commodities into finished or semi-finished products, packaging in appropriate containers, proper storage and exports. The food processing industry in Bangladesh is at very early stages of development. The policy, institutional and infrastructure barriers to agribusiness, agro-processing and supply chain need to be removed in order to provide a "big push" to agriculture and rural development. The main driving force for the development of horticulture crops, livestock, fisheries, food processing and the development of the RNF sector has been the expanding demand for these products. As shown in Table 8, the income elasticity of demand for cereals is much lower as compared to the income elasticity of demand for non-cereal crops (mainly vegetables), fruits, fish, livestock products and the items produced in the industrial and service sectors. With appropriate incentives and institutional framework, these agricultural sub-sectors and the RNF sector are expected to grow in the future. The production and processing of these products is also labor intensive and, therefore, is likely to have a significant favorable impact for generating additional employment in the rural areas.

Table 3 : Income Elasticity of Demand for Major Product Groups

Items	Income Elasticity	
	Rural	Urban
Food:	0.65	0.58
Cereal	0.30	0.23
Non-cereal crops	0.72	0.55
Fruits	1.15	1.04
Fish	1.08	0.87
Livestock Products	1.50	1.25
Manufactures:	0.84	0.78
Clothing	0.92	0.80
Other industrial products	0.80	0.77
Services:	1.52	1.39
Housing	1.18	1.30
Education	2.01	1.70
Health Care	1.13	0.92
Transport	1.70	1.65
Recreation	2.36	1.82
Other Services	1.46	0.97
Savings	2.13	1.77

Source: Hossain 2003 [16].

V. Options for Bangladesh

Formulation of Policy by Government:

We are in the threshold of twenty first century, which has been recognized as century of knowledge based economy, where science and technology will be the prime mover of society. In the backdrop of information and biotechnological revolution as well as emergence of rule based international trade under the umbrella of WTO, there has emerged new setting of agro-techno-economy. Bangladesh is in need of reorient its whole agro-technology policy instrument and other allied factors for gaining agro-industrial competence in a competitive free market economy. Therefore, an adhoc committee comprising representatives from related ministries to be formed to make an integrated effective policy and guidelines for agro-based industry which should be farmer, trader and investor friendly.

Improving the Technology System Management:

Focus should be given making the research and extension programs more effective and relevant to the small and marginal farmers. There should have been a clear vision on national agro-technological setting in the context of country's existing socio-economic situation and emerging globalization process. In order to gain

national agro-technological competence, implementable perspective agro-technological plans and programmes should be chalked out. Some of the elements have been identified as crucial for these efforts of attainment.

- ✓ Drawing up a long-range vision of agro- technological transition with adoption Agro-Technology Master Plan for next 25 years with embodiment of forecasting the goods to be produced and services to be provided.
- ✓ Bangladesh should redefine the goals, formulate new strategies and chart a new course in respect to agro-based industrial development.
- ✓ Establishment of an agro S&T information Bank to facilitate knowledge of agro technology Shelf to the users and act as the vital link to world agro technology sources, as well as to locally developed agro technologies.
- ✓ Co-ordination for selective indigenous capability building using the pragmatic strategy of make-some- and buy some technologies; Reverse engineering techniques may be encouraged for local assimilation of imported technologies.
- ✓ Prioritization of agro technology to be done in pursuance with the long range vision and strategical choice of technological transitions for future.

Linking Small-Scale Farmers to Markets through Post-Harvest Technologies:

- ✓ Post-harvest technologies may be arranged for small scale farmers through private sector and financial institutes to improve the self –life of the food crops, getting access to niche market and increase the income.
- ✓ Need to build capacities at small-scale levels in order to keep farmers competitive in the market by the concerted efforts between Research Institutions, service providers, development organizations, farmers' organizations, etc.
- ✓ Emphasis to be given on transforming subsistence agriculture to make farming a business and entrepreneurial culture to be promoted in rural communities, and farmers need to be trained to produce for market.
- ✓ Encourage the demand-driven farming systems which embed farming with market knowledge.

Diversification in Agricultural Research and Extension:

Without national commitment to address the institutional problems of the technology system the country would not be able to make the best use of human and financial resources to accelerate the growth of a diversifying agriculture sector. Beside crops research other sub-sectors i.e. poultry, aquaculture, horticulture and livestock should also given due importance to improve through research. Focus to be given in poultry, aquaculture and horticulture and livestock extension with crops extension. In this regards, adequate funds should be allotted for operational purposes and it should functions top down –bottom up concept i.e. policy should be from top and feedback to be taken from bottom (farmers).

Development of Agricultural Marketing Information Services:

Agricultural Marketing Information Services (AMIS) is very important for all stakeholders of agri – industry. The small farmers need accurate and timely information about the market price to fix his price in rural area. Government may encourage private sectors to invest in this sector. Internet based AMIS may be introduced besides electronic and print media may be used. In all the cases the 4As i.e. accuracy, availability, applicability and analysis of market information should be focused.

Developing Inland and Marine Fisheries:

Initiatives have to be taken by the government and private sector for developing the inland water and marine fishing and its marketing in a better coordinated way in terms of:

- ✓ Capacity building relating to marine-culture, integrated rice-fish technique, open water fishing through developing appropriate technologies and human skills.
- ✓ Development of related infrastructure.
- ✓ Development of effective policy and networks.

VI. Conclusion

This agricultural research has been done to improve new technologies and technology transfer for increasing the productivity in agricultural sector. Agricultural technology is an attempted to identify the strength and weakness of the country. To remove the present weakness technology equipment and expertise are required. Though there are lots of opportunities in agricultural industry but agricultural industry is facing huge and multifarious challenges. These challenges need to be overcome by concerted efforts of Government, private entrepreneur, NGOs and international related organization. Government may formulate agro industrial policy

conducive to small –scale farmer as well as all stakeholders of agricultural-based industry. Private entrepreneurs and financial institutes should come forward to explore the huge potentials of country's agricultural sector. Agricultural trade has been an important contributor to improved food security and price stability in Bangladesh. For solving the problem of technology transfer in our country an adequate fund allocation is necessary. It is hope that the technology generation and its adaptation at beneficiary level will meet the challenge of stuff security and supportable development in Bangladesh.

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CASE STUDY 1: TECHNOLOGY IN DIVERSIFIED FISHING AND MARKETING

(Aquaculture Sub-sector)

Din Mohammad of Mohespur, Jhenidah initially started business in horticulture but did not get interest due to slow progress. Subsequently, he switched to aquaculture i.e. in fisheries sector. He launched his business with 4 leased ponds and made net profit Taka 50,000.00 in the first year. But in the next year his business flushed away due to heavy flood. He was mentally traumatized and running here and there and finally with the advice of his uncle went to local BRAC office for loan assistance. He took taka 5,00,000.00 loan in phases and technical training from BRAC in regards to business selection, budget management, marketing, proper utilization of assists and risk management to run his business. Within short time he flourished in his business and become a role model in his area and could influence other to involve in the same sector. More so, he took technical training from local fisheries department on integrated rice-fish technology and open water fishing i.e. cage fishing. These, helped him to take his business to a greater height. Now he is focusing on processing aspects and exporting the fishes in Western and European market.

CASE STUDY 2: TECHNOLOGY IN PACKAGING AND PRESERVATION

(Horticulture Sub-sector)

Abu Jergom Md Khosru lives in Jalashi, Panchogor. He independently started agro business with taka 2, 00,000.00 in the year 2005. At present he is doing business of stocking (Aratdari) paddy, rice, tomato etc. He directly collects the product from farmers. To make his business better he always try to find out newer technique. In his area the tomato production is high but 20-30% tomato damages during harvesting, processing and storage. To overcome the problems he wanted to apply technology of packaging, preservation and marketing. He felt lack of funds and technical knowledge. Accordingly, he received both training and funds from BADP. Since then with the technical assistance and consultancy support from BADP he continued to excel in his business. He collects products from field farmer and wholesalers and utilizing his scientific knowledge he grades the products in different group, packed and do marketing in Dhaka with good price. At the moment his business capital has increased to taka 16, 00,000 and appointed 8 permanent staff in his business. Now he is a successful agro based businessman.

CASE STUDY 3: TECHNOLOGY IN PRESERVATION
(Livestock Sub-sector)

Md Rejaul Karim of Sirajganj inherited cattle farming from his father. After his HSC he went outside the country but came back earning some money to do something better in the country. His father was doing cattle farming with direct assistance from local BRAC office through training, consultancy and micro credit. Their business was not generating much of profit as the price of milk in local market was low. Rejaul Karim invested in his family business and distributed 15 cows to 15 different farmers. But the problem was in preserving and marketing the pure milk before it is spoiled. He with the help of local technicians attempted to develop a chilling plant for the preservation of milk. In 2008 he established a mini chilling plant taking loan of taka 2,00,000 from the BRAC office. He took a technical training on dairy from Rural Development Academy, Bogra. Since then with the technical assistance and consultancy support from Bangladesh Agro-based Development Project, BRAC and Pran Group he continued to excel in his business. He took more taka 5,50,000 loan from BRAC and established two more chilling plant. Presently he can store 3,000 liters of milk at a time. Pran Group is his sole customer. At the moment he appointed 6 permanent staff in his project and integrated 200 grass root level farmers in his business. Introducing chilling machine once straggling Rejaul Karim has become a successful entrepreneur in agro-based marketing.