Exploring Agricultural Advancements in Bangladesh – Unravelling the Adoption and Diffusion Dynamics

Dr Sharif Uddin Ahmed Rana, Humaira Tanzila and Mohammad Mahbubul Haque

Abstract: Bangladesh has witnessed impressive strides in poverty reduction alongside commendable GDP growth in the past decade. Significant governmental investments have been directed towards fostering indigenous agricultural innovations. However, despite these efforts, the sustainability of domestic food grain production remains a concern, exacerbated by the observation that the technologies adopted by farmers often diverge from those directly funded by the government. Regrettably, there exists a dearth of comprehensive assessments regarding whether rural farmers in Bangladesh prefer local innovations over imported ones. Moreover, the crucial factors that either facilitate or impede the adoption of agricultural innovations, as well as strategies to address these challenges, remain largely unexplored. Thus, the primary aim of this research is to delve deeper into the adoption-diffusion process of agricultural technology. By understanding this process, we aim to discern why certain participants along the agricultural value chain opt for local innovations over imported ones, or vice versa. This paper undertakes a comprehensive review of existing knowledge surrounding the adoption-diffusion process, scrutinizes the influencing factors behind the adoption of agricultural innovations, and elucidates the perspectives of agricultural technology users in Bangladesh. Furthermore, it demonstrates how the successful adoption of such technologies can significantly contribute to the economic development of Bangladesh.

Key Words: Agricultural innovations; Adoption-diffusion process; Attitude towards technology; Economic development of Bangladesh.

1.Introduction: Bangladesh has made significant strides in poverty reduction in recent decades, boasting a GDP growth rate of 7.65% during 2017-18. However, approximately one-third of the rural population still lives below the upper poverty line, with many relying heavily on agriculture (Malek et al., 2016). To foster modernization and enhance crop and livestock production, the Government of Bangladesh (GOB) has allocated substantial resources over the past decade to develop home-grown agricultural innovations through innovative research initiatives. These efforts have notably led to self-sufficiency in rice production. Nonetheless, the sustainability of domestic food grain production remains a pressing concern (National Food Policy, 2008-2015).

Anecdotal evidence and observations reveal that the technological innovations adopted by farmers often originate from neighboring countries, rather than being domestically funded. For instance, farm machinery is frequently imported from nations like China. However, there has been no comprehensive assessment to determine whether rural farmers in Bangladesh prefer local or imported agricultural innovations. Moreover, the key factors that facilitate or hinder the adoption of agricultural innovation, as well as strategies to address these challenges, remain unclear.

This research aims to delve into the adoption-diffusion process of agricultural technology to better understand why agricultural value chain participants may opt for

local or imported innovations. By exploring existing knowledge on this process, examining factors influencing innovation adoption, and elucidating the attitudes of agricultural technology users in Bangladesh, this paper seeks to shed light on these critical issues. Furthermore, it posits that the successful adoption of agricultural technology has the potential to significantly contribute to the national development of Bangladesh.

2.Theoretical Background

The success of any technology depends on its dissemination among the potential users, which ultimately is measured by the level of adoption of the technology (Shah *et al.,* 2014**).** Adoption is the mental process an individual passes from first hearing about an innovation to final use of the same (Rogers, 1962). There are several theories in the existing literature that focuses on adoption of an innovation. These theories include Diffusion of Innovation (DOI) theory (Rogers, 1995), Technology Adoption Model (TAM) (Davies *et al.,* 1989), and Unified Theory of Acceptance and Use of Technology (UTAT) model (Venkatesh *et al.,* 2003), among others.

The DOI theory explains and predicts the influence of a wide range of factors on innovation adoption and implementation. These include the social system (individuals, i.e. the targeted adopters, their peers, family members, etc.), the perceived nature of the innovation, such as its advantages, complexity and compatibility; and formal and informal communication between individuals in relation to the innovation (Russell & Hoag, 2004). TAM focuses on three factors such as perceived usefulness, perceived ease of use and attitude towards technology that influence actual use of the technology. On the other hand, UTAT model emphasizes on performance expectancy, effort expectancy, social influence and facilitating conditions that influence behavioural intention and use behaviour of the technology. UTAT model further states that gender, age and experience moderate the links between the above-mentioned factors and use behaviour of the technology. In addition, Mathieson (1991) and Mun et al., (2006) argued that human and social factors play a role in the adoption of technology using Theory of Planned Behaviour (TPB) (Ajzen, 1991). TPB focuses on beliefs, attitude and intention that influence actual behaviour where various personal and environmental factors act as background influencing factors for beliefs.

3.Categories of Agricultural Innovations

Innovations refers to “doing of new things or the doing of things that are already being done in a new way.” (Schumpeter, 1947:151). In agricultural context, innovations can be of following eight types based on their forms (Sunding & Zilberman, 2001): (i) Mechanical (e.g., tractors), (ii) Chemical (e.g., pesticides), (iii) Biological (e.g., seed varieties), (iv) Process or Managerial (e.g., Integrated pest management), (v) Agronomic (e.g., new farm management practice), (vi) Biotechnological (e.g., genetic modification), (vii) Institutional (e.g., water users’ association, farmers’ cooperative), and (viii) Informational (e.g., new market information). Innovation can also be following five types based on their impact (Sunding & Zilberman, 1999): new product, yield-increasing innovations, cost-reducing innovations, innovations that enhance product quality, and

innovations that protect health and environment. Adoption of an innovation can be at individual level as well as at farm level.

4.Factors Influencing Adoption of Agricultural Technology

Guided by the above-mentioned theories, extant research focuses on several factors that influence agricultural innovations in various developing countries including Bangladesh. For example, Lee (2005) argued that technology adoption in agriculture is a social learning process and is positively influenced by several factors such as agro-climatic conditions, soil quality, and plot characteristics to input substitution, labour intensity, and improved management capacity. The capacities are based on farmers' age, experience and skills acquired in the formal educational system, through extension services and farmer-based organizations, as well as access to quality information through institutions, networks of NGOs and Government. From the extant literature (e.g., Shah *et al.,* 2014), it is evident that farm size, education, credit constraints, social network and learning influence the adoption of the technical agricultural innovations that include mechanical, chemical, biological, and biotechnological innovations. This is primarily due to the size of investment involved in adopting these technologies. On the other hand, adoption of process or managerial innovations are influenced by education, training, government and NGO support (Bucciarelli *et al.,* 2010; Prodhan & Khan, 2018; Sakiband & Afrad, 2014) since any new process is usually implemented through government and NGO support. Besides, adoption of institutional and informational innovations (e.g., e-agriculture) are also influenced by education, age, income and government support (OECD, 2001).

5.Attitude towards Technology Adoption

The attitude towards an object refers to as an individual's general belief and/or feeling of favourableness or un-favourableness that leads to their behaviour (Ajzen & Fishbein, 1980). The attitude towards adoption of an innovation is influenced by its attributes such as the perceived benefits of that innovation (Rogers, 1995; Quaddus & Hofmeyer, 2007), complexities and compatibilities involved in the adoption process (Rogers, 1995), social (Fini *et al.,* 2012) and situational views (Fini *et al.,* 2009) towards the innovation. Perceived benefits of an agricultural innovation are the extent to which the users believe that accepting the innovation will enhance their performance or will offer any specific benefits such an increase in income (Davis, 1989). Compatibility with the existing knowledge is another key issue that may influence users' attitude. Russell and Hoag (2004) asserted that compatibility is an attribute of perceived benefits and is positively related to the adoption of a new information technology system. The complexities are negatively related to the attitude towards adoption decision (Russell & Hoag, 2004). In addition, user attitude is also influenced by consumers' perceptions of whether their behaviours are accepted, encouraged and implemented by others within their social surroundings; and by the factors derived from the prevailing situation. Social surroundings is often termed as social influence (SI) (Fini *et al.,* 2012; Lucas & Spitler, 1999) or subjective norm, as per TPB. Again, past literature illustrates the importance of external environmental support or situational factors (SF) such as government and NGO support in influencing the attitude towards the technology (Fini *et al.,* 2009). The more support received by individuals, and the fewer obstacles or impediments they

anticipate, the greater their perceived control and positive attitude will be towards the innovation adoption (Armitage & Conner, 2001; Fini *et al.,* 2012).

6.Users of Agricultural Innovations in Bangladesh

The users of agricultural innovations are not only limited to the farmers rather actual users are scattered throughout the agricultural value chains including marginal farmers, fishers, land lords, boat owners, middlemen such as aratders, processors, wholesalers, depot owners, technology retailers, sales people, cooperatives, farmers' and/or processors' associations, and so on. Although the value chain may be different for different agricultural produces, yet long and complex value chain is a common attribute of any agricultural produces in Bangladesh. All the participants across the value chain and also other relevant stakeholders such as NGOs, Government bodies, university researchers as well as NARS officials are also key users of agricultural technology. Again, anecdotal evidence suggest that the users primarily depend on imported mechanical and chemical agricultural innovations. While home-grown biological innovations such a high yielding seed are widely used by the farmers, yet with regards to the process or managerial and informational innovations, there are evidence that the rural farmers are adopting these technologies in an incremental manner and more government and NGO support is required in this regard.

7.Impact of Adopting Agricultural Innovations on Bangladesh Economy

Successful adoption of agricultural innovations may have enormous positive impact on a country's economic development. The growth in agriculture depends on yield-increasing technological innovations, which is essential for fostering economic development and feeding growing populations in most developing countries (Mendola, 2007); and Bangladesh is a very good example on this. Despite increased number of population (more than 160 million) in the country, Bangladesh has become self-sufficient in producing food because of the mechanization and technology (Hasnat, 2018). Instead of engaging cattle, farmers now involve mechanized process for ploughing, raise multiple crops in a year, with high yielding seeds, and improved irrigation system, and thus the farmers are getting the most out of their small lands. The country has produced 388.15 lakh metric tons of grain cereal (rice, wheat and maize), 160.42 lakh metric tons of vegetables during the 2016-17 fiscal year (GOB 2017-18). These facts shows that agricultural development of the country contributes to the overall economic growth and development of the country.

However, use of modern technology in agriculture may produce adverse environmental tangible impacts such as soil fertility, fish catches, and health effects as well as intangible impacts such as, toxicity in water and soils (Rahman, 2003). Unfortunately, the farmers of Bangladesh are not fully aware of these adverse effects due to their lack adequate education and training. Besides, the level and duration of modern agricultural technology adoption directly influence awareness of such adverse effects (Rahman, 2003). In addition, the country's agricultural sector experiencing the adverse effects of climate change (Misra, 2017). These concerns underscore the need for innovation and diffusion of agricultural technologies that do not produce any adverse effects on the environment as well as help the Bangladeshi farmers to minimize the climate change impacts. Since the rural poor people of the country primarily depend on agriculture as

their primary source of income, one of the reasons for their poverty is the low productivity that results from sub-optimal use of inputs and other technologies in agriculture (Malek *et al.,* 2016). To foster agricultural productivity and rural development, it is imperative that technological innovations reach the poor farmers in rural Bangladesh. The agricultural technology need to be diffused and adopted with systematic and location-specific actions related to technology needs, agricultural systems, ecological resources and poverty characteristics (Malek *et al.,* 2016). For widespread diffusion of agricultural technology and the policy-making regarding this, it is necessary to know the adoption pattern of both local and imported technology and their impacts (Noltze *et al.,* 2012; Islam, 2016).

8.Conclusion

This paper offers an understanding of the adoption-diffusion process, types of agricultural innovations, factors influencing and attitude towards adoption of agricultural innovations in Bangladesh. The paper also shows that successful adoption of agricultural innovations have a positive impact on economic development of Bangladesh. Since there are numerous types of agricultural innovations that are adopted across the entire agricultural value chain and improper management of such adoption process may cause problems, it is timely to conduct an in-depth study on assessing the adoption-diffusion process of agricultural innovations across the agricultural value chain of Bangladesh.

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Transforming Bangladesh Agriculture: Enhancing Productivity through Commercialization and the Struggle to Connect Smallholders with Global Markets

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Abstract: The primary aim of this study is to examine the evolving issues and obstacles associated with the transformation of Bangladesh's agricultural sector. Agriculture stands as the cornerstone of Bangladesh's economy, with its GDP witnessing a remarkable surge since independence, soaring from US$ 5.21 billion in FY 1973-74 to US$ 28.92 billion in FY 2014-15. Notably, the average growth in agricultural GDP reached 3.5% during the Sixth Five Year Plan period, playing a pivotal role in achieving rice self-sufficiency and serving as the largest employer, thus contributing significantly to poverty alleviation. Regression analysis demonstrates a positive correlation between increased agricultural GDP per worker and reduced poverty rates over the years, with substantial reductions witnessed over the past 15 years. Furthermore, an analysis of Total Factor Productivity (TFP) of rice production from 2004 to 2014, based on data collected from 10,000 rice farmers across 64 districts, reveals notable trends. Modern Aus and Aman rice varieties experienced TFP increases of 2.3% and 19.6%, respectively, while the TFP of modern boro declined by 16.8% yet remained positive. Overall, the TFP of total rice production saw a 1.9% increase during the same period, with improved efficiency observed in boro rice growers, signaling the potential for a 12% increase in rice output with the same input levels as in 2004. Additionally, significant progress has been made in vegetable and fruit production. The study also conducts a detailed analysis of six key drivers fueling the commercialization and transformation of Bangladesh's agriculture in the upcoming decades. These drivers encompass soil fertility and fertilizer use, irrigation, high-yield variety (HYV) seeds, agricultural credit, technology innovation and adoption, and agro-processing, value chain, and exports. Furthermore, the paper sheds light on the challenges associated with agricultural transformation and the market integration of smallholders.

Key words: Commercialization of Agriculture; Productivity; Smallholding farms; Global markets

1. Introduction

The overall objectives of the study are to focus on emerging issues and challenges in Bangladesh agriculture in the context of the national objective of transforming Bangladesh agriculture for ensuring food and nutrition security over the coming decades.

1.1. Contribution of Agriculture to GDP Growth and Poverty Reduction

The agricultural GDP grew with an average growth rate of about 3.7% p.a., from 1997 to 2013. Agriculture being an important engine of growth of the economy, the government has invested in this sector to develop it for the alleviation of poverty and achievement of food security and the generation of employment opportunities for the huge population of the country are both directly linked to the development of agriculture. The relative shares of crops, livestock and fisheries changed little over the years. The agriculture of Bangladesh is dominated by crops which now account for 68% of total agricultural GDP.

Bangladesh experienced substantial poverty reduction during the last 15 years. During this period, the average annual rate of poverty reduction was 1.4%. It was found that GDP growth had a higher impact on poverty in Bangladesh than other south Asian counties. Regression analysis showed that there is a negative relationship between poverty rates and GDP per worker from agriculture and non-agriculture. As GDP per worker increased poverty rate reduced. The estimated coefficient for agricultural GDP per worker is significantly higher than that for non-agriculture GDP. The coefficient of agriculture GDP per worker is -0.39 and is highly significant at the 1% level. It implies that, other things remaining the same, for 1 percent increase of income of agriculture GDP per worker would reduce poverty by 0.39 percent.

2. Analysis of the shifting paradigm in productivity of agriculture:

Over the last 30 years, rice production tripled from approximately 10 million metric tons in the mid-1970s to almost 34 million tons in 2014/15. Such productivity improvement came through the adoption of high-yielding varieties with the use of irrigation and chemical fertilizers. It enabled Bangladesh to enhance food availability to meet the demands of a rapidly growing population.

The crop agriculture of Bangladesh is still dominated by rice; around 78% of the land is covered by it. To analyze changes in productivity growth, the total factor productivity (TFP) of rice was estimated for the production period 2004 and 2014 using a panel data from 10000 sample of rice farmers from 64 districts of Bangladesh. It was found that the TFP of modern Aus and Aman rice increased by 2.3% and 19.6%, respectively while the TFP modern boro declined by 16.8% but remained positive and the TFP of total rice increased by 1.9% during 2004-2014. During 2004-2014, rice output produced per man-day of labour use and per kg of fertilizer use increased over the years. We have also estimated farm specific mean technical efficiency of the sample boro rice farmers for the period 2004 and 2014. The mean efficiency of the sample boro rice farmers was 68% in 2004 and it increased to 80% in 2014. It implies that 12% more rice output could be produced in 2014 compared to using the same level of inputs used in 2004. It shows that there is a considerable improvement in the mean technical efficiency of the sample farmers over the last decade. The main driver of reducing inefficiency in rice production was the human capital of the farmer, i.e, education, training and experience of the

farmers. There was also steady growth in productivity of vegetables and fruits in Bangladesh.

3. The drivers of the transformation of Bangladesh agriculture for the coming decades:

Driver 1: Soil fertility and fertilizer use: Balanced fertilization is the key to enhancing crop productivity and maintenance of good soil health. It evident from different studies that severe leaching of N and K are going on in the country's soil system causing low productivity of soils and decline in crop yields. Apart from the natural factors, a major reason is unbalanced use of fertilizer. Awareness-raising for balanced fertilizer application and popularization of more efficient fertilizer application techniques, can help preserve soil quality, raise output, lower costs of production. Food production of this country can be increased through expansion of HYVs and balanced use of fertilizer. Timely supply and availability of fertilizer should receive top priority to increase crop production in Bangladesh over the next decades.

As part of government policy to promote balanced use of different fertilizers by reducing use of urea and increasing the use of non-urea fertilizers, the Government in the past drastically reduced prices of non-urea fertilizers (TSP, MP and DAP) while the price of urea was raised. In line with the Government policy, urea use decreased while TSP and MoP use increased since 2012-13. Although the government is trying to promote balanced use of fertilizers for crop production through the implementation of fertilizer policy and New Agricultural Extension Policy still there exists high extent of imbalance fertilizer use at the farmer's level. There is a knowledge gap of the farmers on the recommended fertilizer dose. Promoting balanced fertilizer use could be an important tool for transforming agricultural productivity in the next decades.

Driver 2: Irrigation use**:** Expansion of minor irrigation through groundwater using STWs was the vital component of the GoB's strategy in the past to facilitate irrigation for agricultural development. Agricultural growth in the country has been largely due to the expansion of minor irrigation with private sector investment. There was an increasing trend of irrigation growth in Bangladesh from 1982 to 2014. A regression analysis showed that the degree of acceleration in irrigation was stimulated by the market privatization of minor irrigation equipment.

Rice production accounts for 93% of the total Consumptive Water Use (CWU) and 90% of the total irrigation CWU in Bangladesh. Boro rice accounts for almost all the irrigation CWU of rice. The total irrigation water demand (CWU) for Boro rice production in Bangladesh was 11.8 Billion m^3 in 2000 with 265 mm per ha CWU. Water demand has increased by 40% to 16.5 Billion m^3 in 2010.We have estimated irrigation CWU demand in 2030 and 2050 by using the irrigation CWU per hectare of 2010 level. We have projected that water demand for Boro rice in 2030 will be 17.23 Billion M^3 after this period it will stabilize and would remain at 17.23 Billion M^3 in 2041 of which 13 Billion M^3 would come from groundwater.

Groundwater is the source for more than 75% of the irrigated area in Bangladesh. It contributed to about 13 Billion m^3 of irrigation CWU in 2010. A large part of this CWU is from natural recharge and the balance is from return flows of surface water irrigation. Already we have caused much stress on ground water level. In order to reduce ground water use, we need to increase water use efficiency in crop production and enhance the utilization of surface water irrigation. Given the falling groundwater tables and water quality issues in Bangladesh, it will be extremely difficult to exploit groundwater resources. Without an increase in water productivity (WP), it will be difficult to meet future water demand in 2030 and 2041.

Driver 3: HYV Seeds: During the 1990s to 2000s the seed market has been liberalized with the New Seed Policy 1993, Seed Amendment Acts 1997 and 2005, and the Seed Rules 1998 and opened market for participation and rise of private enterprises in seed production, import, and distribution. In Bangladesh the national requirement for quality seeds of all crops is estimated to be 9,32,250 metric tons. The performance of the seed supply system through quality seed replacement rate (SRR) against national requirement up to 2013-14 was 25% of which about 80 percent seed is being fulfilled through the informal seed system of farmers' own saved seeds.

Agricultural growth is dependent on a very wide-scale switch to HYV seeds, but seed quality in general remains a major problem. Various related investments are needed to enhance the provision of quality seeds in adequate quantities. Some of the non-government organizations and the private sector have started to enter the seed sector with positive impacts on availability, although quality still remains a vexing issue in some cases. Further private-public partnerships for seed, marketing, and extension need to be promoted in the next decades of perspective planning period (2030-41).

Driver 4: Agricultural credit: Agricultural credit, as an input, plays an important role in driving the agriculture of Bangladesh towards a sustainable level. Food security, employment generation and poverty alleviation are closely linked with the development of the agriculture sector. There was an increasing trend in the disbursement of agricultural credit during 2005-2016. While the demand for credit is increasing with the advent of new technologies and high-value crops, the supply side has remained less vibrant. According to data of the Bangladesh Bank, around 25 percent total disbursement of rural credit is delivered by the public sector. The remaining 75% has been delivered by micro-finance institutions (MFIs). The demand for credit is much more than that met by non-institutional sources.

Driver 5: Technology generation and adoption: The options for improving agricultural productivity in the coming decades are promoting balanced use of land and water resource, improving soil fertility, varietal development, improved technology and mechanization. Technological breakthrough is needed for the development of improved varieties of rice, wheat, maize, vegetables, spices and fruits. The new HYV varieties should be resilient of diseases and climate change. Supports are needed for the development of agricultural research and extension for appropriate technology

generation and dissemination for the future decades. The Sixth and Seventh FYP prioritized the importance of research and extension for promoting agricultural intensification, diversification and resilience to climate change.

Driver 6: Developing agro-processing, value chains and exports*:* The size of the food processing sector is worth US $2.2 billion and it grew on an average at 7.8 percent per annum between FY2004/05 and FY2015/16. The food processing sector is thus growing rapidly with prospects for continued growth as Bangladesh's GDP continues to grow. Bangladesh exports annually over $700 million worth of processed food and beverages. Export of fresh fruits and vegetables from Bangladesh significantly increased in the past decade. Frozen foods are the second largest export sector of the economy. The export potential of fruit and vegetables is about 160 thousand metric tons and potatoes would be around 200 thousand metric tons.

Technology and innovations support entrepreneurship in agricultural value chains creating new opportunities to reduce costs and raise incomes. Emerging technologies driven by the Fourth Industrial Revolution include digital database, automation and modern manufacturing, new energy technologies and genomics that all offer significant opportunities for the food system.

Agricultural production is a private sector activity comprised of millions of private smallholder farmers. These small farms occupy almost three-quarters of the land in low-income countries and two-thirds of land in the lower-middle-income countries. While smallholders include subsistence farmers and commercial producers who sell in unstructured local markets and those who sell in more organized markets often under contract with buyers. Many productive off-farm activities in agricultural value chains in developing countries are undertaken by small and medium scale enterprises (SMEs).

Now a day, agricultural markets are globalizing rapidly. As a result, new consumption patterns and new production and distribution systems are occurring in the regions. In the changing market environment, value chains are controlled by emerging corporate firms and supermarkets and their share of the agri-food systems is increasing in developing regions. Small-scale producers provide over 70% of the world's food needs while agribusinesses are important generators of employment and income worldwide. Improving the sustainability of food value chains can benefit hundreds of millions of poor households in developing countries, ensuring access to nutritious food to all. For instance, about 100 types of fruits and vegetables are exported from Bangladesh to more than 40 countries in the world. Export of fresh fruits and vegetables from Bangladesh significantly increased in the past decade

Food manufacturing industry being an actor of value chain contributes significantly to a nation's economic development through converting raw agricultural products into finished goods for consumption. Its products are commonly the major exports from a developing country. For instance, frozen foods are the second largest export sector of

Bangladesh. The massive natural resources available in Bangladesh make this sector particularly promising for investors looking to supply in international as well as in domestic markets.

There are potentials to transform Bangladesh's export markets of fresh, frozen horticultural crops and processed food. It is projected that Bangladesh's export value could be increased to around $1,765 million US $ per year from the export of fresh and processed foods in the year 2034 from the base year level export value of 380 million US$ in 2015. This would require capacity development of value chain actors, compliance of certification of food quality and safety and improvement of storage and transportation facilities.

4. Challenges:

The paper identified a number of key challenges that need to be addressed for the transformation of Bangladesh Agriculture and improving market linkages of the smallholders. These are (i) Technological breakthrough for enhancing and transformation, (ii) Reducing postharvest loss, (iii) Value chains challenge of small-scale operators, (iv) Compliance of Food quality and safety regulations and (v) Labour shortage and mechanization problems, etc.

Commercialization of Aquaculture in Bangladesh: Accomplishments, Challenges, and Future Outlook

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Abstract

Aquaculture in Bangladesh has transformed from a subsistence-oriented endeavor by small-scale farmers into a commercial sector of the economy. From mid 1980s, different government organizations and research institutes have been contributed significantly to develop economically viable and environmentally compatible technology and successfully transferred to the farmers. Consequently, a notable amount of rice land has been converted to fish farming due to high profitability associated with fish production. Therefore, both aquaculture production and productivity have increased tremendously during the last three decades and export earning has increased significantly. Not just in production but also in many off-farm segments, such as rural and urban traders, fish seed producer and suppliers, other input dealers and feed mills have developed which has created a more competitive environment that pushed the adoption of new technologies. This paper is an attempt to present an overview of the present status of aquaculture commercialization of Bangladesh, its causes, problems and prospects.

Aquaculture can be divided into two as: freshwater and brackish water aquaculture. Freshwater aquaculture satisfies the domestic consumption; on the other hand, brackish water earns a considerable amount of foreign exchange. The freshwater aquaculture includes pond aquaculture, rice-fish culture on seasonal farmland, cage culture in rivers and lakes, pen culture in closed and open water bodies, and fish culture in such commonly held perennial water bodies as oxbow lakes. Annual production growth rate of culture fish was 7.2% between 1984-85 to 1994-95 and it has increased up to 11.8% in 1995-96 to 2016-17 (DoF 1985 to 2017; Khan et al. 2009). This higher production growth rate has been achieved due to the innovation, dissemination and adoption of new technologies. Consequently, the share of aquaculture to total fish production increased from 18.2% to 57.2% during 1986 to 2018 period. In order to meet the domestic fish demand for the growing population, governments of Bangladesh and different NGO's have taken different initiatives to increase the pond fish production. These initiatives contributed positively to the expansion of aquaculture area and productivity. On the other hand, due to an overall high profitability in fish farming compared to rice, farmers are more interested to culture fish in some parts of Bangladesh. In 1984-85, area under freshwater

pond was 125 thousand hectares but expansion grew rapidly up to 350 thousand hectares in 2016-17 with 9.3% annual growth rate.

Bangladesh is blessed with brackish water resources which cover about 21 southern districts of Bangladesh (located in Chittagong, Cox's Bazar, Khulna, Satkhira and Bagerhat belt) facing the Bay of Bengal. Due to international market demand and its contribution to foreign exchange earnings, shrimp sector has expanded rapidly. During the last three decades, a countable production growth rate (annual 11.3%) and yield has taken place in shrimp sector. Only shrimp contributes 85% share of total export income from fish and fish products and it has ranged between 80 to 90 percent over the last three decades. The gap between production and export quantity has increased rapidly and grew up from 22 to 65 percent during 1985-86 to 2016-17, which implies that only 35% of total produced shrimp is being exported.

Bangladesh is fortunate in having an extensive inland water resources and extensive coastline which is very productive. Her near-shore seas, rivers, estuaries and mangroves, lakes and ponds all offer tremendous opportunities for fish farming. The soil, water and climate of Bangladesh are very favourable for inland fisheries, both open and closed water. Inland fisheries cover an area of 4.65 million hectares' land of which 86.5% is inland open water (capture fisheries area). The floodplain, *beels* and Kaptai lake covering more than 3 million hectare has tremendous scope to augment fish production by adopting culture-based fishery enhancement technique. These land and water availability has accelerated the scope of aquaculture commercialization and a revolutionary change has occurred in the pond as well as shrimp farming sector. In 1985-86, the total land area under pond and shrimp farming was only 87 thousand hectares but it shot up to 246 thousand hectares in 2016-17.

There are some influential variables that are important to farmers in Bangladesh regarding land use decisions, allocated to available crops. The fish farming is dominated over crop farming under the influential variables of 'production rate', 'total revenue' and 'price growth rate' of fisheries in Bangladesh. Results revealed that the total revenue, production rate, and output price growth rate for fish farming were, respectively, 6, 2, and 1.6 times higher than those of rice farming, these made the fish farming more attractive to farmers than rice farming.

Technology plays an important role for commercialization of any product. Different aquaculture technology i.e. exotic species, comprising mostly Chinese carps, have been introduced include silver carp, grass carp, bighead, carp, black carp, common carp, silver

barb and tilapia. These fish species are very suitable for Bangladeshi weather. Culture practices are mainly improved-extensive and semi-intensive. BFRI has developed more than 30 technology packages for dissemination. DoF, the leading fisheries extension and development agency in the country, disseminates various aquaculture technology packages to farms. Several NGOs also do research on alternative technology packages focusing on poverty alleviation, such as the Cage Aquaculture for Greater Economic Security package.

Fingerling availability and quality fingerling is the precondition for aquaculture commercialization. Until late 1980s, rivers were the main sources of carp seed. Afterwards a phenomenal growth took place in fish hatchery, especially in the private sector. During the 1970s, the public sector (government) began producing quality fish seed through artificial breeding techniques by establishing a number of hatcheries. During the mid-1980s, basic training on fish breeding and hatchery operation and management was undertaken, initially by DOF, and later by BFRI. Until 1988, the public and private sectors established only 77 and 162 hatcheries, respectively but the number has rapidly increased after 1990s. More than 95% spawn requirement is met from induced breeding which enhanced the aquaculture productivity and commercialization.

Feed is the main input for commercial aquaculture where industrial pellet is being used. Since last two decades, fish feed manufacturing companies have been increasing because of increasing demands of fish in the local market as population is increasing simultaneously here in Bangladesh, inadequate good quality fish feeds in the market, optimum production cost, high elasticity of the market, better annual turnover of fish feed manufacturing companies and greater prospect of fresh water fish processing and exportation in the near future and day by day more and more people are involving in fish culture. Now, about 61 commercial fish firms are producing more than 3.9 million tonnes of fish feed. The number of feed producers, importers and retailers is growing rapidly, in line with the expansion of the aquaculture industry.

Just over a decade ago, rural fish farmers usually sold their fish to local traders; now they are selling two-thirds of their product to large wholesalers based in towns and cities. The fish available at market has also changed; the rank of Carp fish was top in the rural and urban market but the situation is changing over the years, some other native varieties of fishes such as *pabda*, *shing*, *mola*, *tengra*, etc. are rising, adding diversity to the fish supply available in markets. At the same time, the production of *pangus* and tilapia, which

were the dominant fish culture for a long time, were decreasing due to low market price and the high production cost, where feed cost holds the major share of production cost.

The number of shrimp processing plants has increased with the increasing shrimp export. Until 1971, there were only nine processing industry plants with a production capacity of approximately 58.5 metric tons per day and all processed fish was exported in the USA and EU market. Afterwards, a remarkable development has been achieved in processing industry and about 40 processing plants were constructed during 1972 to 1984 and the number grew to 124 in 1999. Until 2004, there were 131 shrimp processing plants in Bangladesh but used only 35% of their capacity which implies that 65% excess capacity exists in shrimp industry (DoF 2005-2006).

Different types of institutions have been developed for fishery management which can be grouped in three main complementary categories: management, advisory and research. In Bangladesh, at least fourteen public organizations and departments are involved in the planning, research, promotion, development, management and regulation of the fisheries sector. The Department of Fisheries (DoF) is the main and biggest government organization under the Ministry of Fisheries and Livestock which was first established in the undivided Bengal of the British India in 1908 and since then it has contributed in the production, research, planning, and management in overall fisheries sector in Bangladesh. In 1967, the Faculty of Fisheries was established in the Bangladesh Agricultural University (BAU) which is the first faculty of fisheries on the Indian subcontinent, making a significant milestone in fisheries research and education in Bangladesh. Until early nineties, capture fisheries were the main contributing component of the fisheries sector and all policy and institutional activities was capture fishing based. After establishing of Bangladesh Fisheries Research Institute (BFRI) in 1984, fisheries research received momentum and culture based fishery or aquaculture expanded significantly. Economically viable, socially acceptable and environmentally compatible technologies have been generated through the fisheries research which has made a significant contribution to the growth of aquaculture. All these technologies have been successfully transferred and distributed to farmers.

Although availability of seeds, feeds and nutrition (fertilizer, medicine, etc.) are the pillars of rapid commercialization of this sector but also low-quality seed, high cost of commercial feed, and nutrition are the major problems faced by the pond fish farmers. Still, yields are much lower than the attainable capabilities because of ineffective feeding niches, lack of quality seed and well managed systems. Production process starts with an

untreated and dubious types of seed that forces to gain the lower yield rate in pond fish farming. Afterwards, farm-made and raw unformulated feeds are replacing with commercial pelleted feeds, associated with growth and intensification and commercialization of aquaculture. Over the year, the production of commercial feeds has increased at an average rate of 32% and has reached an estimated total of 1.5 million tons in 2016, while demand has increased from 1.8 to 2.5 million tons over the same period, at the same time, feed prices increased at a rate of between 9 and 15% per year, due to increases in the price of major raw materials and unavailability. The retail price of 3–4 mm grower feed is currently 35–42 BDT/kg for sinking pellet feed, and 48–54 BDT/kg for extruded floating feed, depending on the species. Higher prices of feed are the practical constraint of further flourishing of this sector, however, the potential for increasing yields in much of the existing extensive and semi-intensive sector is considerable.

Fish stocks are affected throughout its life cycle by unorganized management system in all types of aquaculture production systems such as extensive, semi-intensive and intensive. Improper management can losses of stocks more than 20-30% through serious disease outbreaks and for especially sensitive stocks, almost complete mortality can result if disease is untreated. If stocks survive, they may be damaged physiologically or reduced in market quality, both of which represent serious financial loss.

In the case of aquaculture, the concern is whether the fish is produced through sustainably managed aquaculture. The rationale for labelling information at the point of sale is that it links fisheries products to their productions process. Ecolabels are used to support claims that the products come from stocks that are in an ecosystem-friendly manner. Interest in eco-labelling in the fisheries sector is increasing and there is potential for growth in the market share of eco-labelled products. If fisheries management improves, due to the efforts undertaken to comply with certification criteria, the potential benefits to fisheries will be very significant. Traceability is another major issue for fisheries trade. This legislation requires that all fishery products traded be labelled with information on the type of the product (whether it is farmed or wild, origin, catching method, etc.) The advantage of traceability is that it can help ensure the quality of products and identify unsafe products. Most stakeholders in the fisheries sector are unaware of this measure until now and are therefore not prepared to deal with the emerging issues of eco-labelling, traceability and block-chain technology.

The Progress, Challenges, and Future Outlook of Aquaculture Commercialization in Bangladesh

Dr Sharif Uddin Ahmed Rana and David J Kelly

Abstract: Bangladesh is experiencing a quiet revolution in aquaculture farming and business that is having a direct impact on improving livelihoods, nutrition, employment generation, both in urban and rural areas. Aquaculture in Bangladesh has transformed from a subsistence-oriented endeavor by smallscale farmers into a commercial sector of the economy. This paper is an attempt to present an overview of the aquaculture commercialization of Bangladesh considering the achievements, problems and prospects. From mid-1980s, di_ erent government organizations and research institutes have contributed signifi cantly to develop economically viable and environmentally compatible agricultural technologies and successfully transferred to the farmers and market actors. Consequently, a notable amount of rice land has been converted to commercial fi sh farming dueto high profi tability associated with fi sh production. Therefore, both aquaculture production and productivity have increased tremendously during the last three decades and export earning has also increased signifi cantly. Not just the production unit of fi sh but also many o_ -farm segments, such as rural and urban traders, fi sh seed producer and suppliers, other input dealers and feed mills have developed which have created a more competitive environment that pushed the sector to be commercialized through the adoption of new technologies. Nevertheless, the fi sh market is far from satisfactory a level in terms of space, sanitation, drainage and management, and the value chain is still complex in nature. Many constraints are responsible for slow commercialization of aquaculture such as poor quality of seed, high price of industrial feed and low-quality feed, poor structure of supply chain, biological hazard in the supply chain, capital shortage, appropriate technology, inadequate extension service, proper policy, rules and regulations, etc. However, appropriate price policy, introducing eco-labeling and block chain technology can accelerate further commercialization of aquaculture in Bangladesh.

Keywords:

Though we don’t know when and from where Bengali has got the title ‘ masey vatey bangali’, it is easily permissible that fish was a major food for Bengali people from a long time ago. The main secret behind getting this title was the availability of fish .rivers, canals, bills spread all around Bangladesh like a net. As a result, fish was naturally available which we couldn’t imagine. Man could catch fish willingly from canals, bills, rivers, ponds to meet their needs. Fishermen could meet the demand for fish easily by selling them in the urban market.

We have also seen the abundance of natural fish after the liberation war of Bangladesh in 1971. In that time natural open water body was the main source of fish for 7.5 crore people. But the higher-income people living in villages cultured fish in their ponds to meet the family needs. They took it as a hobby. Moreover, this fish cultivation system was traditional where fingerlings were stocked in the ponds without giving feeds or

taking any extra care. These fishes were captured during a marriage ceremony or for family purposes. But the demand for fish has been increased with the growth of the population. As a result the tendency of capturing natural fish has been increased. We have started to use different techniques and tools for catching fish. For that reason the availability of natural fish has been decreasing day by day. Moreover some species of fish are getting extinction due to excessive capturing of these species.

The fisheries sector of Bangladesh has played an important role in our economy from the beginning period. A mentionable portion of our GDP has come from this sector. Not only it plays a role in our economy but also it is the main source of our animal protein. On the other hand, people living beside canals, bills, river-side have taken catching fish as their profession. At present 1.20 crore people have involved with this fisheries sector both directly and indirectly(Ref). There is a necessity for the cultivation of fish with the increasing demand for it. As a result fish cultivation started massively in the middle of the 80s. Many people had taken it as a profession as fish cultivation was profitable. It was gradually going for commercialization. The most important factor that has worked behind the success of fish farming is the availability of fresh and saline water.

In 1971 the total amount of captured fish from the inland water body(freshwater cultured fish) was 650 thousand MT which reaches 3622 thousand MT at present(FAOSTAT, DoF, 2017-18). The cultivation of fish in freshwater has increased massively in the north-western part of Bangladesh especially in Mymensingh, Chittagong, Comilla, Bogura, Rajshahi, Tangail, Jamalpur. On the other hand, the cultivation of fish in saline water has increased in the south-western coastal region of Bangladesh especially in Khulna,Satkhira,Jessore,Bagerhat naiad Patuakhali. In 1983-1984,289thousand hectares land was used for cultivation of fish in freshwater which is now 539 thousand hectares. On the other side 665.2 thousand hectares lands were used for cultivation of shrimp in saline water which is now 259 thousand hectares(DoF,1985-86,2017-18). The only reason behind this transformation of lands into ponds is the profit from fish cultivation which is several times greater than other agricultural crop production. This profit has transformed the fisheries sector from cultivation of fish for family consumption to commercialization.

The fish cultivation has turned into commercialization from family-based cultivation because of some major factors. They are as follows:

1. Space factors
2. Economic factors
3. Technology factors
4. Market and marketing factors
5. Institutional factors
6. Social factors

1.Space factors:

Geographically Bangladesh is in a lucky position for its vast inland water body and coastal area. Its rivers, estuaries, mangrove forests are suitable places for fish cultivation. Furthermore, soil, water and climatic condition of Bangladesh are in favor of fish cultivation. There are 4.65 million hectares inland water body for fish of which 82.5% is open water body e.g. rivers, canals, bills, haors, and 17.5% is closed water body e.g. ponds,ghers, etc. There are .85 million hectares of land only for river and 3.08 million hectares of land for flood plain, bill, captai lake(Ref). The area of inland open water bodies has not increased in the last 30 years. We couldn't maintain a favorable environment in our many rivers and bills for living of fish. On the other hand the cultivation of fish in inland closed water bodies especially in ponds has increased at least 2 times in the past 30 years. At present there are more than 18 million ponds in Bangladesh whose total area is 392 thousand hectares. There are also .06 million dighis.Fish cultivation in ponds has played major role in the commercialization of fish. In 1987-88 the amount of fish cultivation in pond was 146 thousand MT which becomes 1900 thousand MT in 2017-18(DoF 2017-18). The demand for inland fish is mostly fulfilling by cultivation of fish in ponds. The abundance of land for digging ponds has influenced fish cultivation that has helped in commercialization of fish. On the other hand, there is a revolutionary change in the cultivation of shrimp in saline water. In Bangladesh shrimp cultivation has started commercially with the increasing demand for shrimp in foreign countries. In 1985-86 there were 87 thousand hectares of land under shrimp cultivation. In 2016-17 it has expanded over 259 thousand hectares(DoF 1987-88, 2017-18).

2.Economic Factors

In an economic sense, the main goal of a businessman is profit maximization. A businessman tries to attain maximum profit by using his limited resources. He chooses that enterprise which gives him maximum profit. I40 years ago fish cultivation in Bangladesh was only for meeting family demand. But gradually people have chosen it as a profession when they saw it profitable. Due to the availability of highly productive sustainable exotic fish species fishermen find it as the most profitable which has encouraged them to fish cultivation. In research, it has found that fish cultivation is 2-3 times more profitable than rice cultivation. Besides this, shrimp cultivation is almost 6 times profitable than rice cultivation.

Table: Comparative Analysis of income from rice and fish cultivations(Tk/hectare/year)

Elements	Fish	Aus.rice	Amon rice	Boro rice
Total Fixed Cost	38761	4565	14857	18177
Total Variable Cost	136950	45318	36686	69886
Total Cost	175711	50630	51543	88146
Toral Revenue	362046	47144	64823	1219895
Profit	186335	-2739	13280	41749

Revenue/Cost	2.1	.9	1.3	1.5

Many rice farmer has turned their lands into ponds by digging them when they see fish cultivation is profitable. We can find this scenario in Mymensingh,Bogura,Jessore, Comilla district. Educated young people have established a commercial fish farm instead of findings job by taking loan from different credit giving institutions. In the last 40 years, huge amounts of rice cultivating lands have turned into fish cultivating ponds. In 1983-84 the total amount of land for fish cultivation in ponds was 147 thousand hectares which have reached 392 thousand hectares in 2017-18. The cultivation of endogenous fish species like pabda, shing, magur, shol, tengra has increased. The market price of these fish species is high as they have a high demand. For that reason, farmers are able to earn more profits. On the other hand the market price of pangus and tilapia is less than other fishes. As a result these 2 species are known as 'fish of poor people'. But the farmers cultivating pungus and tilapia fishes are gaining profits as the per hectare production of these 2 species are higher than other fish species. The educated people have involved not only with fish cultivation but also with every stage of supply chain. For that reason, fish cultivation has got mobility and thus it increases profit.

3.Technological Factors

The technological advancement of backward and forward supply chain linkages plays the most important role in the commercialization of that product. The fisheries sector of Bangladesh has moved to commercialization as we are using our own technologies and innovations and technologies importing from other countries in our fish cultivation system. We can classify this factor into 4 parts.

A. Adoption of exotic fish species

The exotic fish species have come to Bangladesh in the middle of the 50's. in 1954 tilapia fish was delivered for the first time in Bangladesh from Thailand. Then bighead carps, grass carp, sarputi,common carp,pungus has come gradually to our country. These exotic fish species are in favor of our weather for cultivation and their production is higher than local endogenous fish species. Mainly commercialization of fish farming has started in Bangladesh after coming this exogenous fish species in Bangladesh. At present pungus , tilapia, carps are the main fish species coming under commercialization. A list of exogenous fish species that are imported from abroad is given below:

Table: List of Fishes Imported from Foreign Countries to Bangladesh

Species Name	Scientific Name	Imported From	Year
Tilapia	*Tilapia mossambica*	Thailand	1954
Grass carp	*Ctenopharyngodon idellus*	Hong Kong	1966

Silver carp	*Hypophthalmichthys molitrix*	Hong Kong	1969
Nilotica	*Oreochromis nilotica*	Thailand	1974
Thai Sarputi	*Puntius gonionitus*	Thailand	1977
Mirror carp	*Cyprinus carpio var.specularis*	Nepal	1979
Bighead carp	*Aristichthys nobilis*	Nepal	1981
Thai pangas	*Pangasius hypophthalmas*	Thailand	1990
Monosex tilapia	*Genetically Improved farmed Tilapia*	Phillipines	1994

B. Develop genetically improved varieties

The innovation of genetically improved fish species has been done through the genetic transformation of different fish species in the early 80's for increasing production as well as make commercialization of fish profitable. Bangladesh Fisheries Research Institute and World Fish Bangladesh conducted research on it and they have already developed some improved varieties of fish. The main reason behind development of new varieties is fulfilling the demand for fish in our country through increasing fish production. A fisherman likes those fish species having well prevention capacity from diseases and higher production. Considering the profitability BFRI has invented Rajputi fish species through genetic selection which production is 30-35% higher than traditional Rajputi. Besides this BFRI has also invented super tilapia which production is 43% high. The innovation of new Rui fish species has 12-16% higher production than traditional Rui fish. World Fish Bangladesh has launched a program on genetic development of different carp species and later this organization has played important role in total fish production through distributing these fish species among farmers. In 2013 Genetically Improvement program was launched under the financial assistance of USAID. Thus 1st and 2nd generation of Rui fish were invented respectively in 2017 &2018. Besides that 1stgeneration of Catla and Silver carp fish has been invented in 2019. The innovation of these new fish varieties has created confidence among fish farmers and thus turns fish into a commercial product.

C. Production Input Availability

The potentiality of commercialization of any agricultural product depends on the availability of its raw materials, product's market, transportation system, the complementary product of its and alternative ways of income, etc. it is evenly applicable for fish. Fish feeds and quality fingerlings are the most important raw materials involved in fish production. Salt, fertilizer, and labor are major raw materials in commercial fish farming. But the main aim of a commercial fish farmer is to manage good quality fish feeds and fingerlings. He who uses good quality feeds and fingerlings will gain a profit.

Bangladesh has gained unprecedented success in the production of fingerlings. The demand for fingerlings increases with the expansion of fish cultivation. For that reason,

the governmental and non-governmental hatchery has increased for production of fingerlings. In 1985-86 there are 80 governmental hatcheries and 60 non-governmental hatcheries in Bangladesh. In 2017 this figure has raised to 83 governmental hatcheries and 818 non-governmental hatcheries. It is mentionable that in 2004-2005 there were 112 governmental hatcheries but later it has been decreased gradually. In 2017-18 the total amount of fingerling production from governmental and non- governmental organizations was 669 thousand kg. protein-enriched feed is an important raw material in fish cultivation. In research it has been found that 70-75% of total cost has gone to feeds. Two decades ago cowdung was used as fish feeds. But due to the increasing demand for fish feeds many businessmen have come forward to invest in fish feed industry. For this reason fish feeds turn into an industry. Now there are more than 100 fish feed industries in Bangladesh which have a capacity to produce nearly 2 million ton feeds. There are various quality of these feeds based on protein percentage. Again there are floating and ,,,, feeds considering the environmental conditions. There is a high price of floating feeds as it is healthy for both water and soil of a pond. These feeds are eaten by fishes from upper level of pond's water so that it can mix with soil of the pond. It maintains quality of water and soil of the pond. But ,,,, feeds are used more than floating feeds as most of the fish farms of Bangladesh are small and falls shortage of capital.

D. Aquatic drugs and machinery innovation

For maintaining the water quality and pests aquatic drugs and chemicals are used by farmers and hatchery owners. In the past fishermen used some chemicals like lime, salt, potassium permanganate, etc. But in recent years some companies are producing drugs and chemicals for commercial fish species. These companies are also doing marketing and thus they have played an important role in fisheries sector. The main reason for using aquatic drugs and chemicals is development of the health of fishes and their growth.

4.Market and Marketing factors

Market and marketing management plays a vital role in the commercialization of fish. We can classify the market and marketing management factors into 4 parts:

A.Market demand for fish

The demand for fish has increased due to the increase in population. 66% of our animal protein is fulfilled by fish only. In research, it has been found that 98.5% family eats fish at least once per 15 days and 60% family eats fish once every 2 days. Per capita fish consumption for all families from poor to rich has increased. In 1985 the per fish consumption was only 8.11kg which has now reached almost 21kg. We can realize that the consumption of fish has increased though the population has also increased. This tendency of higher consumption has encouraged fish farming and commercialization of it.

B. Entrepreneurs

With the increasing demand for fish and expansion of fish production new entrepreneurs have revealed themselves in the supply chain. As a result marketing system has developed and quality fish can be delivered to consumers. Hatchery, fingerlings seller, feed seller, fertilizers, drugs, and pesticides seller are the backward entrepreneurs that have played an important role in fish production. On the other hand forward entrepreneurs are fish marketers, fish processors and logistic support providers.

C.Supply Chain Development

There is always a need for an efficient supply chain for delivering any agricultural product at the right time with the right quality. The efficiency of this supply chain depends on some elements such as quality of product, flow of information and risk-taking ability, efficiency of marketers, reliability on product and customer satisfaction. Traditionally the supply chain of fisheries sector in Bangladesh is a complex one. This chain is so long that there exist unnecessary middlemen. Generally there are 5-6 middlemen between farmer and consumer. As a result consumer needs to pay high price for fishes. Due to the development of transportation system, uses of mobile phone and market information supply chain has got a little bit smaller. It has increased the efficiency of supply chain. Now most of the fish farm follows producer—aratdar---retailer—consumer supply chain

D.Value-Added Product

Fish is a perishable product. So we need to take proper maintenance and preservation to control the quality of fish.Generally fishes are cooked directly after purchasing it from market. Some fishes are dried out and preserved it for selling in the market. But in recent years some resource research institution has made several new products that have been sold in the market. for instance fish finger, fish soup, fish oil,fish ball,fish role,fish samucha,fish fillet ,etc.Kazi Farm,CP Bangladesh, and other farms in Bangladesh has marketed these items.The fisheries scientists of Bangladesh Agricultural University have invented fish noodles, jam but they are not being marketed. The demand for fish will continue to increase if value addition continues.Thus fishermen will be benefitted.

5.Institutional factors

The institution is considered as the main key for the sustainable development of fisheries sector. There is no alternative to efficient and suitable institutions for shaping modern fisheries sector and encouraging its commercialization. There have been made several institutions for maintaining our fisheries sector after the liberation war of Bangladesh in 1971. We can divide these institutions into 3 sections. They are (1)Management Institution (2) Advisory Institution (3) regulatory Institution. Ministry of Livestock and Fisheries is primarily responsible for the regulation, maintenance, and management of fisheries sector. Department of Fisheries is the biggest governmental

organization in Bangladesh which has been established in 1980 during the British period. From then it has been working in the production, research, extension and management sector of fisheries sector.then in 1967 the factors of fisheries has been opened in BAU from mobilizing the research activities. In 1984 Bangladesh Fisheries Research Institute(BFRI) has been launched for mobilizing the research more. Besides that Bangladesh Fisheries Development Corporation(BFDC), Bangladesh Agricultural Research Council(BARC) and other government and non-government universities have been working in this sector. With the help of these institutions innovations of sustainable technologies in the fisheries sector have been started in Bangladesh. Thus the commercialization has been mobilized.

Every year the government budget has been allocated and mid-term and long- term planning has been taken for this sector. For instance Aquaculture Policy. Shrimp Policy, Credit Policy, New Fisheries Management Policy(NFMP), National Fisheries Policy(NFP), Policy for Procurement, Prevention and Management of Fisheries Resources, Policy of Fish Cultivation and Management in Close Water.

6.Social Factors

Once upon a time, it was a misperception that only poor and uneducated people could be involved with fish cultivation. But this misconception has been changed due to the gradual changing scenarios of profit from fish, the export of fish and the adoption of new technologies in fish cultivation. Big fish farms are being opened by rich businessmen. The fish feed business is being totally controlled by big companies e.g. multinational companies.On the other hand the rate of educated people has increased in our country. The educated young people have involved in fish cultivation by taking training on it. New entrepreneurs are getting involved in it. As a result trained and educated people have involved in every stage of supply chain. It has successfully launched the commercialization of fish. It has also changed the traditional perception of common people.Now it is not only a profession of poor people but also a profession of educated and trained people.

The fisheries sector has played an important role in the economy of Bangladesh. The demand for fish has been increasing due to the expansion of the population. It has increased the tendency of fish consumption. As a result we see competition in fish cultivation. In the mid-80s fish cultivation was only for meeting the family needs. But after the commercialization of fish cultivation it has seen more profitable than other agricultural products. For that reason in the last 30 years a mentionable part of rice cultivating lands has been turned into fish farms. Fish feed, fingerlings, and other elements are now available for fishermen. New technologies have been adopted by educated people involved in fish farming. So the supply chain has developed much. Adoption of exogenous fishes, genetic development of endogenous fishes, development of marketing management, research and overall policy of government have helped to make commercialization of the fisheries sector.

Reducing Production Loss in Agricultural Value Chain Management in Bangladesh

Dr Sharif Uddin Ahmed Rana , Donald Steiny and David Smith

Abstract: Loss of agricultural production during post-harvest management, packaging, transportation, storing and processing ranges from 10% to 40% in fruits and vegetables. Post-harvest loss in rice (harvest to store) is about 5 million tons (14%); where as in wheat it is about 0.13 M tons (10%) and in maize about 0.30 million tons(15%), annually. The value of these grains is about US$ 1.68 billion that could feed about 40 million additional mouths a year. Similarly, loss in fruits (30%) and vegetables (25%), potato and spices (30%) incurred economic loss of over US$ 1.3 billion. Moreover, transportation loss about 2% in bulk grain and 10 % in fresh produce; storage loss 5% in grain, 10% in fresh produce increased the load. Total loss in value chain of major crops is estimated to be over US$ 3.0 billion a year, about 87% of the national agricultural budget of 2019-20. These losses could be reduced by improving value chain infrastructures, management, and strengthening agro-processing sector. Reduction of loss in agricultural value chain management would increase nutritious safe food by increasing nutrition security and meet SDG goal of the country.

Key words, Post-harvest loss, Value chain, Agro-processing.

Introduction: Value chain management is a process for organizing, analyzing and implementing the value-added activities during the movement of a product through supply chain. The goal is to establish communication between the leaders of each segment of the chain to ensure value addition and quality product available to customers, timely. Supply chain is a process of changing hands of products from producer, traders, arotdar to processors and consumers. The backward linkage of supply chain starts from seeding to production process and harvesting; while forward linkage continues continuous value addition with post-harvest management, packaging, transportation, storing and processing of products for marketing or consumption. Recording data with traceability information of a product's origin, input used, post-harvest management and value addition is important for confidence building of consumer for successful marketing. In modern marketing, computer base apps being used known as "Block Chain" with "traceability information of the product's origin, production process, post-harvest management, change of hands and value addition activities and pricing, the supermarkets used the apps on their products for customer satisfaction. This presentation deals with the constraints and prospects for agri-business

development in value chain initiatives: post-harvest management, storage, transportation, and agro-processing of major crops.

Post-harvest management: There are over 200 crops grown in Bangladesh. The rice is the main crop in the country covers almost 70% of cultivated land to produce over 53.0 million tons of paddy, MoF 2019. The post- harvest operation of rice including processing are moderately developed around chatal based management system (the post-harvest management facilities with drying, parboiling and/or rice milling process) organized by private sector traders and individual households. The private chatals and individual farm households, handle over 53 million tons of paddy along with about 1.3 million tons of wheat and 3.2 million tons of maize (BBS 2017).

Post-harvest loss in Cereal value chain: Post-harvest loss in rice (harvest to store) in three growing seasons, Aus, Amon & Boro, is about 13.72% where drying loss 2.84%, parboiling loss 2.75% and milling loss 4.54% (BRRI 1986;) that accounts a loss of about 4 to 5 million tons of rice annually. In wheat, post- harvest loss is over 10 % (FAO 2012) to about 0.13 million tons while in maize, post -harvest loss is over 15 percent i.e. 0.3 million tons. This grain loss could feed over 40 million mouths for a year. Moreover, rice milling recovery rates (in coarse grain 60% to 65% and in aromatic rice 58% to 60 %) in the country, lower than neighboring rice producing countries, and there is room to improve milling recovery further using automatic rice milling system. There are over 20,000 rice mills in the country of which about 300 are modern auto rice mills. All rice mills should be renovated with modern technology for which bank loan should be facilitated. With the rise of poultry feed industry, demand for maize increased to 4.0 million tons and the production also increased to 3.2 million tons (BBS 2018). Electric shelling, proper drying and storing facilities for maize in the rural growth centers will be appropriate technology for rural farmers to reduce post-harvest loss. Farmers should be supported with incentives and technical knowledge on postharvest management of maize . A considerable quantity of post-harvest losses could be prevented by using improved shelling, drying facility and storing along with use of its bi products such as maize oil. Bangladesh produces about 1.3 million tons of wheat and imports about 6.0 million tons for bakery and other uses. Post-harvest loss of all grain's accounts over 5.6 million tons. Even 10% savings in post-harvest loss of grain (rice, wheat and maize) may result a substantial increase in national food resources and contribute to GDP.

Post-harvest management in Fresh produces: Post-harvest management of fresh produces in the country is poor. Bangladesh produces about 9.0 million tons of horticultural products (fruits 5.07 million tons and vegetables 4.02 million tons), annually (BBS 2017). Post-harvest loss of fruits and vegetables ranges 23.6% to 45.5% C In fruits, this loss ranges from 5- 20% and in vegetables 10-45% with different **varieties and species. Mango production steadily increasing last 10 years to about 2.3 million tons.**

Pos- harvest loss in fruit value chain: Bangladesh produces over 140 types of tropical fruits including, Mango Banana, Jackfruits, pineapple (DAE 2019). Bangladesh is the 8th largest producer of mango in the world with a production of about 2.3 million tons (BBS

2017). Traditionally, the mango orchards were owned by landlords controlling large areas of land, however; small and medium households are also being increasingly involved in micro-level orchard management. recently. The ease of maintenance of mango orchards and increasing demand of fruit have attracted farmers to mango and other major fruits farming. Similarly, production increased in Banana, Jackfruit, Mellon, Papaya , Gyava, pineapple and other fruits. The post- harvest loss in Mango is about 35%, in Banana is 26%, Guava 49% with huge economic loss (US$ 5.6 million) in the country.

Vegetables, spices and other fresh produce loss in the value chain: Bangladesh produces over 4.02 million tons of vegetables of over 100 types of vegetables. About 25% post-harvest loss of vegetables accounts for an economic loss of about US$ 314 million, annually. Tropical vegetables e.g. Brinjal, pumpkin, cucumber, country bean, gourd etc. are important popular crops while temperate vegetables such as potato, cauliflower, cabbage, tomato etc. grow well in winter and popular to consumers. Potato production is over 10.2 million tons (BBS 2017). Potatoes (fresh and processed) consumption was about 46.4 kg/capita/ year in 2013. Estimated post-harvest loss of potato is over 25% (home stored potatoes was 27.65% and cold storage stored potato was 23.11%) with an economic loss of about US$ 31 million. Despite huge post- harvest loss, about 3.5 million tons of potato is surplus in the country in 2019. Bangladesh Government is giving emphasis for potato export, said the Commerce Minister in an annual general meeting of the Bangladesh Could Storage Association (BCSA) in Dhaka, recently. Inadequate cold storage facility for preservation is a major problem. Moreover, the most potato varieties that grown in the country are mostly for table purpose consumption as vegetable, only a few industrial varieties have been introduced by private sector e.g. Diamond, Courage, Lady Rosetta among others, recently that are gaining popularity in the industrial sector. Similarly, considerable loss occurs in Spices. Among the major spices, Bangladesh produced about 1.87 million tons of onion in 2017 and import of about 0.889 million tons (BBS, 2017) against a demand of 2.2 million tons. Onion incurred about 30% post-harvest loss with economic value of about US$71 million. Moreover, pulses, jute and tea sectors have similar loss due to poor post-harvest handling in the field, in transportation and preservation.

The lack of adequate modern post-harvest technologies and advanced knowledge of farmers, handlers of fruits, vegetables and spices are responsible for this large loss. Moreover, unauthorized use of ripening chemicals also enhances the loss. These high losses are largely due to immature harvesting, poor handling, transportation, packaging, and storage facilities in the value chain. Moreover, poor or no quality control mechanism exist in the rural areas, where ripening and preservation chemicals are used, indiscreetly. High postharvest losses of fruits and vegetables negatively affect food availability, food security, and nutrition, as the net availability of nutritious food for consumers is reduced. An underlying cause of these postharvest losses aggravated due to limited awareness and knowledge of stakeholders (farmers, researchers, NGOs, and traders) about the value chains management, and thus awareness building could improve the knowledge gap (Islam et.al, 2003).

Prospects: Adoption of modern value chain in post- harvest operations with improvement of basic and simple technologies, establishment of post- harvest management shed equipped with sorting, grading, cooling, washing, packaging/bagging facilities in the rural markets, equipped with cool and covered transports to storage, marketing and processing facilities along with research and extension efforts to improve harvesting with mechanization, management and transportation would prevent such huge losses, considerably. Reduction of post-harvest loss would help to meet demand for nutritious food, improve nutrition security to meet SDG goal of the country. This calls more investment in the value chain management, research on harvesting, post-harvest technology, manpower development in agri-business management and public awareness through extension and media.

Transportation loss in the value chain: Agricultural commodities are transported mostly by road, rail and river transports systems in Bangladesh. Air transport is used for exporting perishable fruits and vegetables. Frozen products transported in temperature controlled frozen van and containers. Bangladesh national road system is over 21,000 km. of which National highway covers 3,791 km, regional highway covers 4,206 km, and Zilla roads cover 13,121.757 km, connected to all districts and upazilas. In addition, rural rood system connected to growth center and marketplaces have link to national road systems. The truck, van, rickshaws, bikes, animal driven carts, boat, launch etc., are used to transport agricultural commodities from farm to local, regional or city markets. Most fresh produces, fruits and vegetables are transported by road, more often on the roof top of passenger bus, trucks, considerable products transported by train and river system by boat and launch, leaving the products vulnerable to rain, sun dry that cause loss. Bangladesh railways has over 2,706 kilometers tracks, mainly in the western, central and Eastern regions. A road-rail bridge over the Jamuna River connects the east and west rail way networks. The Railway cargo system transports bulk grains, seed, fertilizers etc., and local traders also used the system for transporting fruits and vegetables to regional and city markets. There are over 8,000 km of navigable waterways, including about 3,058 km of major cargo routes which also use for transporting imported bulk grains and agricultural inputs e.g. fertilizers, and exportable, jute, potatoes etc. to sea ports. Farmers and traders also used country boat, launch and passenger vassals to transport agricultural commodities. Post-harvest loss in transportation of agricultural commodities ranges 6 to 11 percent in fresh produce and in bulk grain transport, the loss is about 1.25% in rail, 1.50% in boat and 1.75%, (Singh 1917). Alavi et al 2012 reported 2% to10% loss during transportation and handling of agricultural commodities in Southeast Asia.

In recent years, a few organizations for example Hortex Foundation, Department of Agricultural Marketing (DAM), and BADC have been popularizing cool van in value chain management of fresh produces. Private companies e.g. Golden Harvest Agro Industries Ltd., uses frozen van in transporting their processed product to distributers maintaining a temperature of -18^{o} C through its cold chain network. According to World Potato Council, Bangladesh is the 7th largest producer of potato and 3rd in Asia, but country is lagging in export (Wardad 2015). Since exporters do not have air-conditioned transportation, export of potato becomes risky. Efforts should be made, and incentives be declared for cool van transportation facilities to augment potato export.

Storage loss in cereal value chain: Cereals, rice, wheat and maize, require storage for a considerable period. Potato requires 4-5month of storage. Some fruits e.g. mango, Banana, pineapple need short time storage for ripening and to avoid market glut in Bangladesh. Rice and wheat are often kept in storage for six to nine months period, while maize mostly goes to private sector feed industry, after shelling and drying and its storing process is addressed in private industry. The level of post-harvest losses, mainly in rice and wheat varies from 10% in wheat to 14% in rice, annually in the country. The losses occur partly due to insect and fungal attack during storage as a result of higher moisture contain than 12%, because of improper post-harvest management. Significant losses in quantity and quality of stored grains occur through the activities of insect pest, microorganisms, mites, and rodents, that in extreme circumstance, cause as much as 50% to 60% loss. Farmers stored about 70% of their cereal grains to meet family consumption and for seeds. Cereal grains are stored either in containers or in bulk. The containers used in rural household include, matka or large earthen pots, gola ghar (bamboo made multi chamber facility) and jute bags. Rice traders use mainly jute bags in various store houses that made either of bricks or corrugated iron sheets, with or without plastered walls, and on earthen or cement floor. The Government stores grain to meet emergency need during natural calamities and for its food based safety net programs. Government's has capacity of about 2.2 million tons of food grains storage in Local Storage Depot (LSD) and Central Storage Depot (CSD) and silos. There are 9 CSDs and 620 LSDs, scattered all over the country with grain storage capacity of about 4 lakh 30 thousand tons and 11 lakh 50 thousand tons, respectively. The country has also 9 silos with a storage capacity of about 3 lakh 60 thousand tons. About 90% of the Government storage is made in bulk and rest in jute bags. The bag storage method is more expensive than bulk storage because it is more labor intensive, require purchasing of bags and storage space. Moreover, bag storage is vulnerable to insect pest attack when expose to high temperature and moisture. Bangladesh Government planned to increase this capacity to around 27.45 lakh tons by 2020 and around 30.0 lakh metric tons by 2025. In this regard, a "Modern Food Storage Facilities Project" in collaboration with the World Bank is being implemented since 2018 to build 8 steel silos (six silos for rice and two for wheat) with a total capacity of 5.36 lakh tons to save the long-term strategic reserves. It is expected that increased stored grain would help combating natural disasters and food safety net program and reduce storage losses, adopting the best suited technology for preservation of grain quality, quantity and nutritional value and ensure safe storage during calamities, better monitoring, improved governance and management of food stocks (World Bank, 2018).

Potato Storage loss in the value chain: According to Bangladesh Bureau of Statistic over 10.3 million tons of potato produced in 2017, and 5.53 million tons of potato kept in 3416 cold storages across the country to maintain a sustainable supply during the year for consumption, seeds, industrial use and export. In a study, Food Planning and Monitoring Unit (FPMU), Dhaka reported that an average harvesting loss of potato was 5.65% where home storage loss for three months storage period was 7.35%. The average loss in cold storage for nine months storage period was 3.82%. The average losses at traders' level for home and cold stored potatoes were 11.95 and 9.61%,

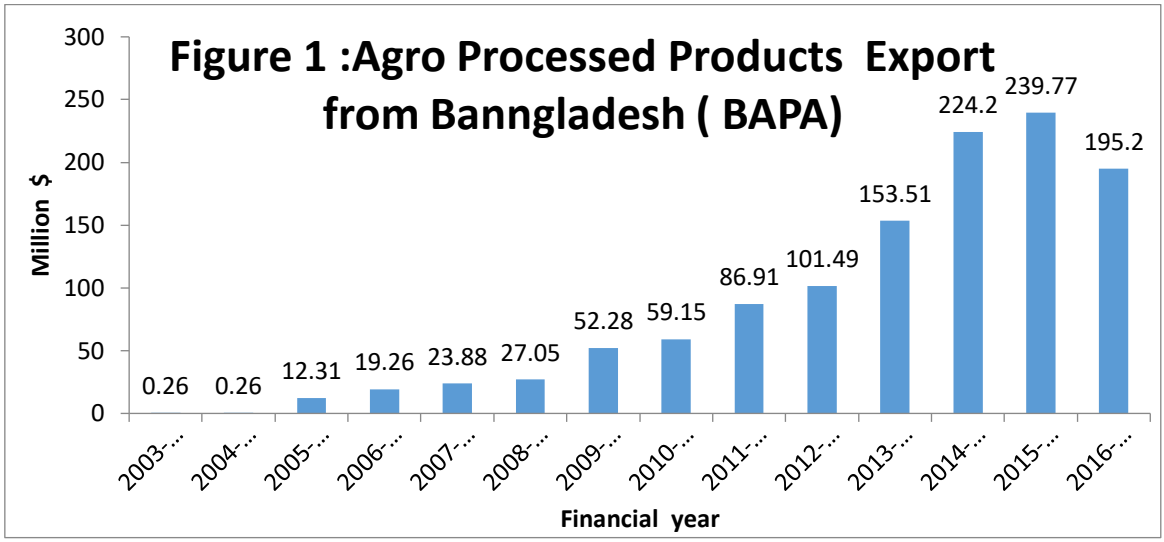
respectively. Household and restaurant levels losses were 3.24, and 4.52%, respectively. Total post-harvest loss of home stored potatoes was 27.65% and cold storage stored potato was 23.11% mainly due to shrinking, physiological disorders, storage diseases and sometimes sprouting of tubers. Despite huge post- harvest loss, about 3.5 million tons of potato is surplus in the country in 2019. Currently, over production of potato is seen as a burden to farmers and businessmen. Bangladesh Government is giving emphasis in potato export, said the Commerce Minister in an annual general meeting of the Bangladesh Could Storage Association (BCSA) in Dhaka, recently. Major importing countries of Bangladeshi potato are Malaysia, Singapore, UAE, Vietnam and Sri Lanka and few other countries. Exporting to Russia is restricted due to complexities related to quality, however, the problems being addressed.[i]

Major problem for Bangladesh potato industry is over production resulting underpricing during and a few weeks after harvesting due to lack of adequate cold storage facilities in the rural areas. Price instability may be reduced with a buffer stock during harvesting and establishing law cost storage facility. For stabilizing potato prices, forecasting of potato prices and target production may be made well ahead of sowing, so that the farmers can adjust potato acreage accordingly. High storing coast due to higher power bills also aggregate the problems. However, promoting export, supporting processing industry to diversify products e.g. Mashed potato, French fry, Potato Chips and soup etc., and promoting low cost natural storing facility in the rural area may ease the storing problems. Development and popularization of varieties suitable for processing could also improve the situation. Potato is consumed as a vegetable in Bangladesh, if percentage of potato consumption is increased, pressure on rice would be reduced, so the storage problems.

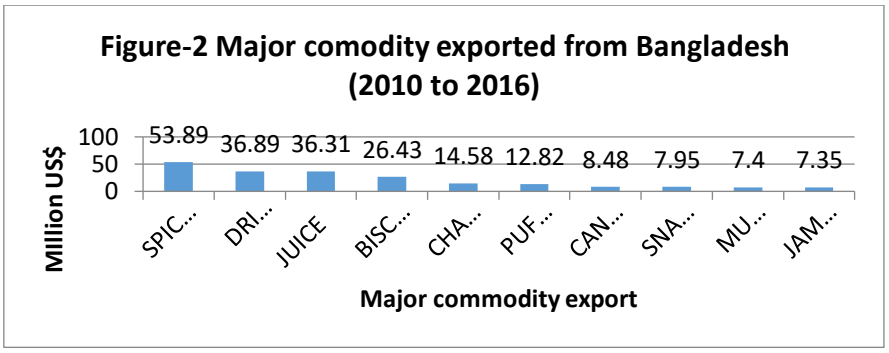
Fresh produce storage loss in value chain: Fruits and vegetables are mostly fresh and perishable products and remains in the markets from few days to few weeks, depending on variety and maturity. Mango, Jackfruits and Banana are kept in ripening shed for a few days to weeks in the secondary markets. The fruits are stored in the market yards or sometimes under a shed, where fruits are arranged in several layers on the ground spread with paddy straw and the top of the lot is covering with straw for mango. Mangoes are kept for two to three weeks for uniform ripening under shed. Then the fruits are distributed to retailers. Retailers purchased the fruits directly from the wholesale agent or Aratdar. They classify the fruits into different sizes and sell within two or three days. Supermarkets maintain 6 to 10-degree cool temperature, but no such facilities are available in the open markets that intensify ripening and spoiling. However, dry fruits need cold storing for 6 to 10 months, depending on market demand under normal or controlled conditions. Storage loss may account for 5% in short term fresh fruits and 8% to 10% in long term dry fruits.

Spices e.g. onion are perishable, need quick marketing. Multi- chamber cold storage facilities needed to store longer. Dry chili being stored at homestead in earthen container and at traders' level in jute bags under corrugated tin shed store house before marking, similarly, other spices such as turmeric stored by traders for a while to sale for higher profit, later in the harvesting season. The commodity loss in storage due to shriveling, spoilage due to disease and physical damages and variation in temperature may account for 5 to 6% of storage loss.

Agro-processing in value chain: One of the ways to reduce the post-harvest loss of agricultural commodities is to strengthen the agro-processing sector at homestead and industrial levels. Bangladesh agro processing sector currently stands over US$ 2.2 billion and grew on average 7.7% per annum between fiscal years 2004-05 and 2010-11. The beverage industry growth rate exceeding 8 % per annum. With the growing middle-class population of over 30 million, the food processing sector is expected to grow positively in the coming years. However, the contribution of the sector to GDP is about 1%. Agro processing has been identified as one of the thrust sectors by the government and several policies such as Industrial Policy 2016, Seventh five year plan and Agriculture Policy 2013 target the agro processing sector. The government also provides tax holidays and cash incentives (20% cash incentive for export of agro processed products) for agro processors. The revenue earned from export of agro products and volume exported both have increased in recent years and nontraditional markets such as Nepal and India have been explored. According to Bangladesh Agro Processor's Association (BAPA), export of agro-processed products from Bangladesh increased from US$ 60 million in 2010-2011 to US$ 240 million in 2015-2016 showing a positive growth in the sector Figure-1 (BAPA 2017). There are over 62 types of processed products exported by 460 BAPA members over the years. The most important products in terms of earning presented in Figure -2.



Procurement is primarily dependent on middlemen which leads to wastage during transportation and increase in price of raw material. Good Agriculture Practice and traceability are required that are not well adopted in production process. Inappropriate packaging, cold transportation and storage facilities need to improve. Food safety in Bangladesh is a multi-sectoral responsibility should be better coordinated.



Source: BAPA 2017

To realize the potential for agro-processing sector further, the following actions need to be undertaken:

- Establishment of an agro processing zone can significantly boost the sector (Government to consider);
- Innovate diversified products in fostering the agro processing industry (public-private partnership)
- Strengthen existing domestic market for agro processing (private sector market promotion)
- Strengthened varietal improvement suitable for industrial processing (public-private partnership)
- Improved quality control and inspection process, strengthen BSTI and support private sector to meet HACCP, ISO and other safe-food requirements (public-private partnership)
- Facilitate skill development especially on industrial productivity improvement, food safety control and supply & value chain management for the agro-processing and Quality Control Personnel (University & industry partnership)

A. Major Challenges and Solution for Advancing Agribusiness

- Poor post-harvest and value chain management. Establish modern postharvest management facility with washing, cleaning, grading, bagging and quality control facilities with BSTI at all upazilas, cool chain transportation for fresh produce to city markets and multipurpose cold storage facilities under Public private partnership (PPP);
- Excess production of course rice and table potato created marketing glut and reduce farmers income; Diversify farming with high value crops, discourage cereal import at least for three years, and provide subsidy to rice and potato exports;
- Law yields and high milling loss in aromatic rice: long grain common and aromatic rice and industrial processing potato varieties are not available. Strengthen priority research to

develop high yielding long grain aromatic rice and high dry matter content (19-22%) potato varieties, organize industry base rice farming, and promote mechanization and agro-processing;

- Limited Government investment in R & D: Increased R& D support to over 2% of GDP; and
- Limited linkage with private sector: Strength private and public partnerships in research extension and agri-business education.

B. Major Opportunities:

- Improved value chain management loss will increase agricultural GDP and help achieving Sustainable Development Goal (SDG);
- Post-harvest management, transportation, storage and processing will open investment opportunity to private sector;
- Establishment of an agro-processing zone, development of long grain common rice, aromatic rice, industrial potato, mango and other crop varieties will promote agro-processing and increase export earnings;
- Revision of import & export policies will open new horizon for rice, potato and other agricultural products marketing;
- Diversification from rice to nutritious and high value crop production will increased nutrition security.

C. Strategies for Agribusiness Capacity Building:

- Industrialization of rice mill-based farming and mechanization of all farming with policy and financial support;
- Strengthen quality control and promote safe food for local and export markets;
- Promotion of agri-business education, research, extension partnerships.

D. Advancing Partnership Building:

- Promote public & private partnerships in agri-business research, extension and education;
- Introduce contemporary agri-business curriculum, as per need of the industry in public and private universities;
- Organize seminar, symposium, workshop with public and private involvement to exchange new ideas and constraints to resolve industrial requirement.

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Empirical Investigation of Sustainable Supply Chain Risk Management in the Dairy Industry: A Case Study in Bangladesh

Dr Sharif Uddin Ahmed Rana, Doanld Steiny and Dr. Souha Akiki

Abstract

Contemporary literature reveals that dairy industry suffers from various kinds of supply chain risks associated with cattle rearing, storing, processing, distribution and forward and backward supply chain activities. However, to date, this sector lacks in-depth research identifying supply chain risks and their associated appropriate mitigation strategies in terms of economic, environment and social sustainability dimensions. The current study depicts existing supply chain risks embedded in the storage, processing and distribution levels of the two dairy companies in Bangladesh and suggests ways to manage them appropriately in order to gain maximum benefits in terms of their social, economic and environmental aspects. The supply chain risks are elicited through structured interviews. Some of the high impact and high probable risks are found to be high rate of interest, absence of insurance coverage, Illiterate and inefficient workers and Hartal and strike. Optimal mitigation strategies are then found through a non-linear optimization process. The optimal mitigation strategies were found to be adequate credit support with low interest rate, purchase insurance against production loss, hiring skilled staff, appropriate training facilities and initiative to remove political uncertainty. Implications of the findings are discussed for various stakeholders of the dairy industry.

Introduction

In recent decades, Bangladesh has attained phenomenal growth in agro-based industries. Dairy, poultry and fisheries are the main livestock sub-sectors in the economy of Bangladesh. These sub-sectors have a reputation for providing cheap sources of protein, creating employment opportunities, and serving as direct and indirect income sources for millions of people (Das et al. 2008). The dairy industry is one of the most important livestock sub-sectors in Bangladesh, contributing in immense ways to the country's economy and society. It is one of the sectors best suited to alleviating poverty in the rural economy of Bangladesh. It generates employment by providing jobs to the whole family. However the dairy farming sector in Bangladesh is beset with different risks in its supply chain. On the input side the sector faces risks like feed scarcity, treatment inadequacy, credit unavailability, low productivity of breeds and so on. Due to the poor functioning of the input sector, the production sector, i.e. farming operation, is also handicapped (Raha and Talukder 2004). The distribution sector is also affected due to limited access to markets, too many middlemen, poor transport facilities and improper infrastructural facilities.

The primary objective of this research is to develop a framework to identify potential risks to supply chain processes of dairy industry and to suggest potential mitigation strategies that can be implemented to mitigate these risks, proactively and reactively. This research falls in the overall domain of supply chain risk management (SCRM) (Bloss, Quaddus and Wee 2009, Chowdhury and Quaddus 2015). A mixed methods approach is employed in the light of contingency theory (Zeithaml, Varadarajan and Zeithaml 1988)

and sustainability theory (Carter and Rogers 2008) by which different risks to the dairy supply chain are categorised. Risk mitigation strategies are developed through the Quality Function Deployment (QFD) tool (Park and Kim 1998, Chowdhury and Quaddus 2015) and the outcomes are analysed through network QFD (Kahraman, Ertay and Büyüközkan 2006). Qualitative and quantitative data are combined with literature support to build a QFD model.

Background

There are plethora of examples of supply chain disruptions due to various events (Sheffi 2005; Christopher and Peck 2004; Thun and Hoenig 2011; among others). A proactive planning of identifying these risks and taking mitigating actions (strategies) would minimize the negative impacts of supply chain risks in any industry. Hence proper supply chain risk management (SCRM) helps a supply chain to prepare for unpredicted disruptions and to recover from unexpected losses. The dairy supply chain in Bangladesh is exclusively dominated by the informal private sector. Only 3% of total production is processed and marketed through formal channels. The remaining 97% is marketed by informal agents in raw form in the supply chain (Hemme and Khan 2004). The dairy supply chain consists of various groups, each performing a dedicated role at a relevant point in the chain. A chain of dairy producers, collectors, middlemen, processors, traders/wholesalers/retailers, and consumers is involved in transferring milk and milk products from producers to consumers (Saadullah 2011). Bangladesh dairy industries, especially small and medium scale industries, face problems related to insufficient supplies, poor technological adoption and low yield at harvest. Small and scattered animal holdings, scarcity of feed and pastureland, and limited availability of quality feed are major constraining factors, which generate risks in commercial growth of the dairy sector. Frequent occurrences of diseases resulting in high losses are also a risk factor.

Therefore, the focus of this research is on identification of risks and investigation of risk management strategies, along with probable sustainable outcomes. More specifically, the research identifies risk factors and explores risk mitigation strategies associated with the dairy supply chain. Subsequently possible sustainable outcomes after implementing suggested risk mitigation strategies are also presented. Two dairies in Bangladesh have been selected as case studies and the research assesses their risks at various supply chain stages and examines their mitigation strategies. Consequently, the variables are used to develop a QFD model for the dairy industry.

Method

The research method consisted of sequential steps. It commenced with an extensive review of the literature related to theories of supply chain risk management. From the literature review, the initial risks, mitigation strategies and sustainable outcomes (after implementing mitigation strategies) for dairy industries were identified. The next step was the conduct of the qualitative field study using interviews and content analysis of the interview responses. The field study findings were then used to refine the risks, mitigation strategies and sustainable outcomes identified from the literature. The next phase

involved the development and design of a questionnaire-based survey using the literature review and field study findings. Data for QFD (Park and Kim 1998, Chowdhury and Quaddus 2015) analysis were collected from the two case companies. These data were collected through a three-part questionnaire-based survey of employees, executives and supply chain members. The gathered quantitative data was then analysed. The Quality Function Deployment (QFD) tool was used to test the effectiveness of the results, which were then interpreted and discussed.

Figure 1 shows the overall research model which guided our research process as described above.

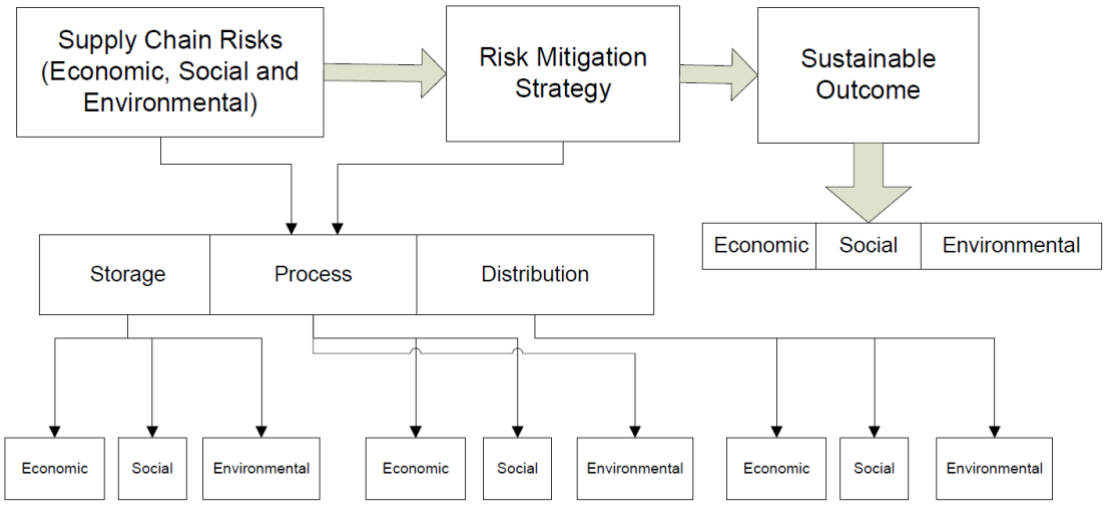

Figure 1: Dairy supply chain risk mitigation model

Results Qualitative Analyses

Exploratory interviews were conducted with the executives of the dairy companies to identify the dairy supply chain risks, risk mitigating strategies and sustainable outcomes of the dairy companies. Tables 1, 2 and 3 present the respective results.

Table 1: Dairy Supply Chain Risks

R1	=	Inadequate loan facilities	R24	=	Bacterial contamination for improper temperature
R2	=	Complex loan procedures	R25	=	Pollution and unhygienic environment
R3	=	High rate of interest	R26	=	Cattle diseases
R4	=	Inadequate finance	R27	=	Machine damage/breakdown at processing unit
R5	=	Absence of insurance or compensation coverage	R28	=	Fire at farm shed
R6	=	Shortage of improved technology (Milking machine, feed mixture, grass cutting, improved processing facilities)	R29	=	Accident (staff injury)

R7	=	Labour disputes	R30	=	Inadequate supply of quality feed
R8	=	Illiteracy and inefficiency of worker	R31	=	High cost of feed and medicine
R9	=	Shortage of skilled staff	R32	=	Scarcity of feed
R10	=	Switching of staff frequently	R33	=	Lack of upgrade vaccination and veterinary services
R11	=	Lack of fixed government policy in dairy sector	R34	=	Shortage of land for expanding farm
R12	=	Poor law and order situation (terrorism, musclemen ship)	R35	=	Irregular supply of vaccine from government
R13	=	Hartal and strike cause delay in work process	R36	=	Competition among the farms
R14	=	Political Unrest and interference	R37	=	Bureaucratic complexity on maintaining various formalities
R15	=	Corruption (adulteration by mixing water)	R38	=	Drought leads to a decline in milk production
R16	=	Damage of farm's assets	R39	=	Accidents of transport vehicle
R17	=	Theft	R40	=	Existence of middlemen/ too many middlemen

R18	=	Natural disaster (flood, excessive rain, storm)	R41	=	Too long chain cause delay in product movement
R19	=	Quick perishability of Milk	R42	=	Poor conditioned road for moving product (delay & spoilage)
R20	=	Machine damage/breakdown at cold storage	R43	=	Inadequate transport facilities to move products frequently
R21	=	Inadequate chilling facilities	R44	=	Lack of milk tanker (refrigerated)
R22	=	Inadequate cold storage	R45	=	Unethical behaviour of middle men (adulteration, added price, deprivation)
R23	=	Spoilage of milk through improper handling			

Table 2: Dairy Supply Chain Risk Mitigation Strategies

S1	=	Adoption of improved technology (Milking machine, feed mixture, grass cutting, improved processing facilities)	S17	=	Strengthen the regular supply of vaccine
S2	=	Buying insurance against production loss.	S18	=	Initiative to reduce the cost of feed
S3	=	Hiring skilled staff	S19	=	Support to develop technology
S4	=	Motivational and incentives facilities for staff	S20	=	Focus on certified feed supplier to get quality feed.
S5	=	Initiative to remove political uncertainty	S21	=	Arrangement of adequate grassland for producing Napier grass
S6	=	Implementation of a fixed policy for dairy sector	S22	=	Arrangement of regular vaccination for the cattle

S7	=	Assurance of adequate institutional credit support with low rate of interest	S23	=	Arrangement of improved and upgraded veterinary services
S8	=	Introducing off-farm activities	S24	=	Building multi-storeyed complex for farm extension
S9	=	Focus on value addition	S25	=	Building monitoring team
S10	=	Promote sound business practices by cooperation, better coordination and information sharing	S26	=	Initiative to develop roads and highways
S11	=	Reduction of risks through merger, acquisition and integration.	S27	=	Arrangement of adequate number of transport
S12	=	Arrangement of proper training to the staff regarding temperature control	S28	=	Arrangement of refrigerated transport facilities
S13	=	Adoption of alternative supply of power for cold storage (powerful generator)	S29	=	Development of roads and highway
S14	=	Arrangement of proper training to the staff regarding processing and hygiene management	S30	=	Focus on product diversification
S15	=	Attempts to create various cross breeds by adopting AI services.	S31	=	Removal of unnecessary influence of middlemen
S16	=	Lease abandoned land to the farmers for dairy farming	S32	=	Direct marketing

Table 3: Sustainable Outcomes

Economic		**Social**	
SO1 =	Profit maximisation	SO8 =	Goodwill enhancement
SO2 =	Cost minimisation	SO9 =	Supply of quality food
SO3 =	Increase in personal income	SO10 =	Nutritional development
SO4 =	Increase in production	SO11 =	Improvement of living standard
SO5 =	Product quality improvement	SO12 =	Creation of employment opportunity
SO6 =	Expansion of farming system	**Environmental**	
SO7 =	Production of value added product and diversified product	SO13 =	Creation of sound working environment
		SO14 =	Waste management
		SO15 =	Supply of quality food

Results of Quantitative analyses

As mentioned earlier network QFD method (Kahraman, Ertay and Büyüközkan 2006) was used to identify the optimal strategies to mitigate high probable and high impact risks. This involved identifying the absolute importance (AI_j) of each mitigation strategy by applying the following equation:

$$AI_j = \sum_{k=1}^{n} DI_k \times REL_{kj}, \forall_j = 1 \ldots\ldots 32$$

Where, k=1…….45, the number of risks; j=1…….32, the number of mitigation strategy; AI_j= absolute importance rating of strategies; $DI_{k=}$ degree of importance (i.e. weights of risks), k=1…….45, the number of the risk, j= 1…….32, the number of the mitigation strategy, REL_{kj}= relationship rating representing the strength of the relationship between risk and mitigation strategy.

The following non-linear optimization model was then employed to identify the optimal strategies to mitigate the risks.

$$Maxf(x) = \sum_{j=1}^{n}(AI_j)X_j$$

$$\text{s.t.} \sum_{j=1}^{n} RC_j X_j - \sum_{i=1}^{n}\sum_{j>i}^{n} SV_{ij} X_i X_j \leq B \text{ (with cost savings)}$$

Where, AIj= absolute technical importance rating of mitigation strategy Sj , Xj=decision variables [0 or 1] for mitigation strategy Sj (i.e. if Sj is selected, xj=1, otherwise it is 0), J= 1…….32, the number of the mitigation strategy; RCj= relative cost for implementing the mitigation strategy; B = budget available for implementing the risk mitigation strategy; SV= savings amount of resource (relative cost) usage associated with simultaneous implementation of two mitigation strategies.

Table 4 presents the results of the optimization model.

Table 4: Comparison of Optimisation Results

Groups	Dairy N Employees	Dairy N Executives	Dairy N SC Members	Dairy P Employees	Dairy P Executives	Dairy P SC Members
Optimum Strategies	S6, S14	S6, S10, S17, S31	S5, S6, S12, S14, S17, S19 S31	S6, S14	S14, S16, S19	S5, S6, S19, S30, S31
Total	2	4	7	2	3	5

Comparing the optimization results some interesting views are observed in the perceptions of various groups of decision makers.

Sustainable outcomes

The final phase of our analyses involved identifying the sustainable outcomes when the strategies are implemented in two dairy companies. This was done using network QFD method ((Kahraman, Ertay and Büyüközkan 2006). For Dairy N, 'Cost minimisation' (SO2) was the best realisable outcome with the highest relative importance (RI) value 0.12. The second most achievable outcome is 'Profit maximisation' (SO1) with an RI value of 0.11. The third most important realisable outcome is 'Increase in production' (SO4) with an RI value 0.10. By contrast, the least achievable outcome with the lowest RI value of 0.02 is 'Improvement of living standard' (SO11). For Dairy P, the most realisable sustainable outcome is 'Increase in production' (SO4) with the highest RI value

of 0.15. Two other important realisable outcomes are 'Cost minimisation' (SO2) and 'Profit maximisation' (SO1) with the RI values of 0.14 and 0.11 respectively. The least realisable outcome is 'Improvement of living standard' (SO11) with an RI value of 0.02.

Conclusion

This paper explicates the supply chain risks embedded in the storage, processing and distribution levels of the two dairy companies in Bangladesh. Taking a mixed method (combination of qualitative and quantitative) approach the study finds the optimal strategies to mitigate the risks in dairy industry. A range of analyses shows the similarities and differences among the optimal strategies. The findings will be of immense help to the stakeholders of the dairy industries in Bangladesh.

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Strategic Imperatives for Bangladesh: Inclusive Agribusiness and Sustainable Development

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Abstract

Inclusive growth requires an inclusive market ecosystem, which, according to these authors, promotes *an increased, equitable, and responsible participation of all market actors, particularly of small and economically-challenged individual market players and MSMEs along the value chains that help reduce poverty and asymmetric distribution of created value.* In a country where nearly 40% people are related to agriculture, a sector that generates around 15% of the country's GDP, sustainable agribusiness competitiveness is a natural way to promote inclusive growth. Bangladesh, recently graduated from a least developed to a developing country, has an outstanding opportunity to work on agribusiness competitiveness and inclusive growth. However, despite reasonable success over the past couple of decades, Bangladesh's agriculture and agribusiness ecosystem is far from ideal. Study of its agricultural value chains reveals inefficiency and incompetency in different segments, indicating significant scope for upgrading. Based on the authors' decade-long experience in dozens of action research and interventions involving agribusiness competitiveness and market system development, this paper presents potentials for upgrading agricultural value chains and improving agribusiness ecosystem. In so doing, the paper relies on Triple Triangle Framework (TTF) and value chain approach, and uses a horticulture value chain as the reference case. The paper identifies three major strategic imperatives: (i) responding to the priorities of agro-enterprises, particularly by developing human resources, promoting decent workplace, improving access to finance , information and market, and by igniting an entrepreneurial culture, (ii) impacting the market ecosystem in order to improve the behavior of market actors and incentivize desired market actions, and (iii) creating and sustaining an enabling business environment with supportive policies, institutions and infrastructure so as to facilitate innovation and technology transfer and promote agro-SMEs' participation in national and global value chains. Market system development strategists, policy makers and researchers are expected to benefit from this work.

Key Words: agribusiness, inclusive market ecosystem, sustainable development, value chain, strategic imperatives, Bangladesh

Abstract: This study aims to examine the economic prospects and challenges of introducing futures market for rice in Bangladesh by: (i) critically reviewing the relevant literature including on South Asian experiences; (ii) examining the pre-conditions for the setting up of a futures market; (iii) investigating the level of readiness to institute such a risk management strategy in Bangladesh; and (iv) drawing policy implications. The study will rely on both primary and secondary sources of data and information. The research approach to be used in this paper will be exploratory, and predominantly be qualitative and descriptive in nature. This study expects to find that, similar to the experiences in other countries, futures market will result in reduction in post-harvest paddy price volatilities, improvement in commodity price risk and credit risk management among many others. In a preliminary literature

survey, we have found that among the challenges that Bangladesh will face for setting up a futures market strategy are (i) the lack of legal and institutional settings and enabling regulations specifically pertaining to the futures contract; (ii) liquidity problem and inadequate financial support; (iii) lack of awareness about 'futures markets' as a risks management strategy and trading platforms; and (iv) smallholder farms.

Keywords: Paddy and processed rice, Price volatilities, Risk management, Futures market, Bangladesh

Introduction

Rice is a major staple food for the people of Bangladesh, providing 45 percent of the calorie intake of the average Bangladeshi household. Over 95 percent of the Bangladeshi farmers, who constitute about 80 percent of the population, grow rice across all agroecological zones. Food security in Bangladesh is equated to availability of adequate supplies of rice both at national and household level. Therefore, being the largest employer in Bangladesh the agriculture sector remains one of the most important sectors of the country.

The farmers who ensure the sector's contribution to the economy often end up getting the short end of the straw. Particularly, farmers do not receive fair price at harvesting period. They have been forced to sell their product at lower prices to the millers and traders. Sometimes, in against price falling rice farmers display widespread protests. The market price is largely being dictated by the millers/traders, who exert too much power as middlemen between farmers and consumers and manipulate the market for profit. Because of its strategic nature, rice price should not being manipulated by the middlemen, rather government needs to do well to ensure that too much of the control is not resting in the hands of the profit seeking business people.

Agricultural markets are inherently unstable where prices fluctuate widely within a season and from one year to the next. Recently this price fluctuations have been a regular phenomenon in Bangladesh agriculture. In the last season, farmers in Bangladesh experienced the worst falling of the paddy prices. Reports of farmers protest, demonstrations and rally came from different corners of the country demanding for fair prices. Even it has been reported that a frustrated farmer set his crop on fire as a protest against low price of paddy rice; farmer committed suicide failing to pay-off debts received from various NGOs and cooperatives after not receiving expected returns from their produced rice. The price volatility in crops lead to the high variability in farm incomes which make them worried and frustrated. Farmers have to hire workers with very high wages to harvest paddy, but they sell their produces at nearly half the production cost.

Under this volatile situation, economists suggested for supporting farmers for various reasons. First, it is argued that government sometimes uses variety of interventions to keep rice price deliberately low which also make the paddy price low in the end. Secondly, it is argued that there is huge income discrimination between farmers and

non-farm producers. The per capita income for rice producers - from rice production only – remain unchanged or falling compared to the growing income of non-farm producers including even rickshaw pullers over the last decades. Thirdly, as compared to farm business no any other business is that risk prone, this sector deserves special support. Another justification of government support is the declining terms of trade of agriculture. A widely held perception is that agriculture's terms of trade secularly decline, as a reflection of Engel's Law whereby demand for agricultural products rises less quickly than for manufactured goods and services as economic growth occurs and incomes rise. The Prebisch–Singer hypothesis argues that the price of primary commodities declines relative to the price of manufactured goods over the long term, which causes the terms of trade of primary-product-based economies to deteriorate. A secular decline in its terms of trade, inevitably makes the agricultural sector disadvantaged. Consequently, agriculture is seen as a declining sector, and one which should receive less policy priority than others in efforts to promote growth. Government intervention in agriculture was therefore justified and was often instituted through marketing boards.

Finally, farmers are demoralizing gradually which may have adverse effects on food security. Nowadays, farming is not by the choice of farmers but by their destiny or by lack of opportunity to be engaged in non-farm sectors. Farmers are no longer interested in engaging their own children in this occupation or even some farmers are leaving farming themselves. If this situation continues, farming will be in real trouble and food security or self-sufficiency in foods would be challenged. Under these circumstances, farmers protections are badly needed and justified too.

To fix this, simply by setting a minimum support price at which the government would buy the rice from the farmers, it could make sure not only that the farmers were getting fair prices but also that the market price was being controlled. However, government have little to influence the paddy market as they have limited capacity to store rice and which become full if there are better harvests in few seasons. Among other alternatives, one possible way to raise farmers earnings is to reduce costs of production. In the case of rice farming, given the subsidized inputs, an expansion in scale necessarily would reduce costs. In this case, farmers association or agricultural cooperatives could help in expanding scale in production. However, to expand the scale of individual farms in a limited area of land causes a reduction in the number of farms.

Therefore, in response to farmers demand for fair price, government has no easy and quick solution. Besides, there is little scope for pushing prices up by subsidized procurement of paddy from farmers when agricultural markets shift from government-regulated price stabilization policies to a free market. Government, thus, has limited scope of direct price support to the farmers. Besides, experts and public policy maker also suggested that before providing agricultural price support it needs to ensure be more careful and justified to make the support truly supportive for the farmers. It needs to analyze why a (marginal) farmer should deserve more public policy support than a non-farm producer as this supporting has to do at the expense of others and with an expensive money. Besides, they mentioned that, in case of Bangladesh, majority of the benefits of govt's subsidies and other supports benefit the big farmers and absentee farmers. Study shows that millers and storage owners extract the maximum market margin.

Moreover, economists argue that direct price support results inefficiency to the farmers. The inefficiency is one of the problems of Bangladesh agriculture – inefficient farmers are engaged in rice farming. It is said that this inefficiency of rice farming is the result of artificial influences that government uses to increase farmers' income and supports rice prices. Besides, in order to maintain the artificially inflated crop prices of domestic crops say rice the government collects tariffs on imported rice which makes some other products expensive. Moreover, to maintain price support, government needs high tax revenue. In the case of the consumption tax increase, the extra burden borne by low income households has become a problem.

As a result, agricultural markets, across the world, are undergoing profound changes. Direct price supports and subsidies are falling, and liberalization is growing. These changes are raising uncertainty and increasing the necessity for risk-shifting strategies. Studies argued that futures can be a valuable weapon in the farmer's collection in the tactical war for survival. The literature indicates that hedging with futures or forward contracts will benefit agricultural producers by offsetting their price risk (e.g., Johnson, 1960; McKinnon, 1967; 1975; Danthine, 1978; Holthausen, 1979; Feder et al., 1980; Lapan and Moschini, 1994; Lubulwa et al., 1996). By using the futures market sellers or buyers can protect themselves against price movements in the underlying physical market. This is achieved by selling or buying futures contracts through a broker who is a member of the futures exchange. Consequently, futures markets allow producers and users of the commodity to hedge their price risk, thereby limiting their exposure to adverse price movements. This encourages increased productivity in the agricultural sector as farmers and users are able to concentrate their efforts on managing production risks.

What is futures?

Futures are documented contracts to buy or sell a commodity or financial product at a later date in time and with a set price. Historically, such futures were traded first in Japan on rice back at the 1700's. However, the modern futures market was introduced in Chicago at the mid of 1800's. The exchanges standardized by specifying the underlying product or asset, delivery date, delivery location, settlement type. The standardization of a futures contract allows it to be traded in a secondary market. Agricultural commodity supply is extremely lumpy during the harvesting season while demand remains very linear. The gap between supply and demand causes huge price swings, and sometimes it happens that prices would be so low farmers would not harvest it or dump their product at the market place instead of transporting it back to home. To face this imbalance situations and minimize loses, farmers and dealers could make contracts to deliver product at a later date for a specific price. As these agreements are identical except price, these can be traded hands in a secondary market. Currently, futures market has become popular and has been operating in many countries. Statistics show that the open interest on Corn alone exceeds 1.4 million contracts.

In case of the futures exchanges, an inherent risk is the counterparty risk. A clearinghouse is important to remedy this counterparty risk associated with futures trading. The clearinghouse eliminates the counterparty risk of futures contracts and

make the market more reliable and functional. It would ensure both sides of the transaction receiving a margin payment from both the buyer and seller. In the futures market, a margin is simply an amount of money that traders must deposit into a margin account of the clearinghouse to hold the futures contract. This amount is set by the clearing houses and is usually quite small, typically less than 10% of the futures price. The margin works as a collateral security and gives the broker confidence in the contract settlements.

Though, the futures market is an exciting corner of the financial markets, there are countries who don't have comprehensive understanding of futures are not interested to enter into a futures contract with the worry of counterparty risk. The goal of this paper is to give a good foundation of knowledge to start digging deeper into the futures market. Particularly, to understand the characteristics of the futures market, how the price of the futures contract against the spot price can impact the cash flows to the margin account, and how moving from one futures contract to another can impact your returns.

A futures contract provides a hedge against a change in the price. It insulates consumer from the price changes. In the futures market, instead of buying and selling crop, the farmer and millers buy and sell contracts that agree to buy. These contracts can be made at any time, even before the farmer plants the crop. Farmers can use the futures market to sell some of their anticipated crops on a certain day in the future. Just enough crop to provide the security that a low price at harvest won't make them looser. Similarly, the millers use the same market to buy crop that protects them against a high price later. In the futures market, the farmer could lose money if the price goes high, though now they can sell the rest of their crops, what was not in that contract, at the higher price that offsets her loss in the futures market. On the contrary, futures contract makes money if the price of crop is low at the harvest time. The profits can be used to shield them from the sting of the low price they will get for the rest crops sells now. The futures contract protect millers from those higher prices and they can use profit to cover the higher price of the crop they now need to buy. This is how the futures market serves as a risk management tool.

In Bangladesh, agriculture is highly prone to variety of risks. Price risk is one of the serious risks that hurts farmers the most. Farmers in Bangladesh rarely use any risk sharing tools to mitigate or control the risks in agriculture. There is no crop insurance and safety net programs to helps protect them from crop devastation or market shocks. Introducing a futures market could be a potential way to manage some of the threats posed by volatile market prices. In case of rice market, farmers always want to sell their crops at a better price. On the other hand, dealers/buyers, the rice millers, are always keen to buy crop at a low price so that they can make a better profit. However, farmers face the challenge of receiving the better price due to the nature of crop harvesting. The whole crops get harvested at a specific period of time and consequently the price falls due to huge supply of crops. Even though, price is appealing to the millers they do not want to purchase all of its crop at once as it would have to pay to store it. Nevertheless, the good thing is that crop can be stored, that means it can be traded round the year. Participation in the futures market, could benefit both producers and dealers of a major agricultural commodity, rice and the benefits eventually trickle down to regular food consumers.

Experience from others

Across the world, the push for adoption comes when agricultural markets shift from government-regulated price stabilization policies to a free market. The literature indicates that hedging with futures or forward contracts will benefit agricultural producers by offsetting their price risk. In the US, 33 per cent farmers use derivatives and even in the more protected EU market, that number is between 3 per cent to 10 per cent. A study in South Africa found that after liberalization, 10 per cent of maize farmers directly participated in the futures (Mofokeng, 2012). Study shows that there are 113 commodity futures contracts in the Indian markets including food grains and pulses, oilseeds and oils, spices, metals, fibers and manufactures and many other commodities. It shows that in the National Commodity and Derivatives Exchange of India the dominant trading items were soya oil, guar seed, and soybean. While in the National Multi Commodity Exchange, pepper, rubber, and raw jute were the most actively traded commodities (Kumar & Garg, 2016).

The Association of Southeast Asian Nations (ASEAN) conducted a feasibility study of establishing a rice futures market in the ASEAN region and its potential benefits in managing price risks. McKenzie and Hamilton agreed on the benefits of a rice futures market in making prices more transparent and in serving as hedging instruments. They contended that the hurdles in developing a rice futures market in the region are not insurmountable and that the process of establishing futures should start now (ADB, 2012).

Similarly, in EU the trade of rice on futures market started in 1994, but the volume of rice traded on futures market is smaller than that of relevant agricultural products. Because, in the EU countries the production of rice is too small for a worthwhile use of futures contracts in the international trading and in the short run domestic market prices can be not strictly linked to world prices. Consequently, producers may not be able to utilize existing international commodities exchanges for hedging purposes (Banterle and Vandone, 2013).

In case of Australian wool producers, it was found that the basis risk, transaction costs, and uncertainty about production cause the optimal hedging ratio to fall. In their study Pannell et al (2008) found that uncertainty about production has only a minor influence and lower price uncertainty also reduces the optimal hedge and may contribute to low use of futures. Study also shows that Ghana set up the National Food Buffer Stock Company (NAFCO) in 2010, to address the problem of post-harvest losses, ensure food security and protect farmers from unfavorable prices during bumper harvest. This became necessary as Ghana experiences post-harvest losses for all staple food crops including maize, rice, cassava, yams, sweet potatoes, sorghum and beans (Ngmenipuo and Issah, 2015).

Farmers are using futures contracts to counter agricultural price risks in India. Report shows that in a bumper crop year when farmers across the country have been battered by lower crop prices, farmers' groups are using futures contracts to hedge against price dips during the harvest season. Other countries that use market instruments for price risk management are Brazil, Ethiopia, Malawi, Ghana, and Nepal. Therefore, as studies

argued, futures can be a valuable weapon in the farmer's collection in the tactical war for survival. Particularly, under the current global phenomena when agricultural markets are undergoing profound changes, falling direct price supports, reduction in subsidies and liberalization which are raising uncertainty, rice futures could necessarily work as risk-shifting strategy. Under these volatile circumstances, this study aims to examine the economic prospects and challenges of introducing futures market for rice in Bangladesh by:

(i) critically reviewing the relevant literature including South Asian experiences;

(ii) examining the pre-conditions for the setting up of a futures market;

(iii) investigating the level of readiness to institute such a risk management strategy in Bangladesh; and

(iv) drawing policy implications.

The study will rely on both primary and secondary sources of data and information. The research approach to be used in this paper will be exploratory, and predominantly be qualitative and descriptive in nature. In a preliminary literature survey, we have found that among the challenges that Bangladesh will face for setting up a futures market strategy are (i) the lack of legal and institutional settings and enabling regulations specifically pertaining to the futures contract; (ii) liquidity problem and inadequate financial support; (iii) lack of awareness about 'futures markets' as a risks management strategy; and (iv) smallholder farms.

Conclusion

Farmers in Bangladesh rarely use any tools to control risks in agriculture. There is no crop insurance and safety net programs to helps protect them from crop devastation. It can be perceived that farmers can manage some of the threats posed by volatile market prices (market risks) by participating in the futures market. This study, therefore, want to better understand how the futures market could help both producers and users of a major commodity, rice. To develop futures market, regulatory reforms, designing other institutional structures, warehouses and clearing house are the preconditions.

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Supply Chain Management in an Urbanizing World: Addressing the Challenges of Rapid Urbanization

Dr Sharif Uddin Ahmed Rana, Moses Ma and Nazmul Hossain

Abstract

Our world is rapidly urbanizing. By 2050, two-thirds of humanity will live in cities. Increasing rates of urbanization are putting more pressures on resources; influencing what foods we eat, where and when we eat them; the way our food is grown, processed and delivered to consumers; and impact on our health and nutrition. Worldwide, interest in urban food systems and the increasing engagement of municipal government in food issues is growing rapidly as cities are largely dependent on external food sources. Food chains are growing longer, global trade is increasing and the diversity of food available to consumers is increasing. However, while urbanization presents many opportunities for smallholder producers, the lack of knowledge, resources and infrastructure continues to limit their participation in modern urban food systems. Furthermore, poverty, food insecurity and malnutrition are shifting from a rural problem to an urban problem. Urban food systems are being challenged to be more inclusive, responsive and resilient. This impacts on the need for greater investment in wholesale marketing and distribution systems, food quality and safety, transport and logistics, and improved food waste management.

Introduction

For the first time in history, the majority of mankind now reside in an urban environment, with that figure expected to reach two thirds by 2050 [1][2]. Increasing rates of urbanisation are putting more pressure on water and land resources; influencing what foods we eat, where and when we eat them; the way our food is grown, processed and delivered to consumers; and impacting on our health and nutrition [3].

While increasing urbanisation presents abundant opportunities for food producers, it also presents a number of significant challenges. Cities occupy only 3 percent of the land area and yet they are responsible for 70 percent of global GDP, 60 percent of the energy consumed, 70 percent of greenhouse gas emissions and 70 percent of global waste [4]. With the demand for food generally exceeding the capacity of the adjacent agricultural region, cities are largely dependent on external food sources. With increasing imports, while the diversity and range of

food available to consumers increases, food chains become longer and with that, cities become more susceptible to climate induced food shortages, food price hikes, breakdowns in logistics and failures in food safety management systems [5].

Furthermore, with increasing urbanisation, both as a result of urban migration and natural population increase, poverty, food insecurity and malnutrition are shifting from a rural problem to an urban problem. Today, more than one billion people reside in informal, low income settlements, where diets are often deficient in terms of calories, diversity and nutrients [1]. As poor households spend scarce resources to buy more affordable, calorie-dense, micronutrient-poor food with high levels of fat, sugar and salt, the incidence of malnutrition and obesity are increasing, often within the same household.

It is also well understood that urban growth directly impacts on the increasing demand for natural resources [3]. Urbanisation contributes to climatic change, modifying hydrologic and biogeochemical cycles, changing precipitation patterns, increasing pollution and reducing biodiversity [1]. Regrettably, the increasing demand for food is not climate neutral, with an estimated 20 percent of greenhouse gas (GHG) emissions being generated by agriculture, forestry and land use change. Agriculture and food production, while contributing directly to climate change, is also directly impacted by a changing climate, with yields projected to fall by as much as 7 percent as a consequence of global warming [6]. Post production, the food system is thought to be responsible for another 6 percent of GHG emissions, arising both from the need for refrigeration to preserve food and the mounting cost of food waste.

Collectively, these issues have led to a renewed focus on food systems, their sustainability and resilience, the potential to create viable employment and livelihoods, and the ability to provide access to affordable, safe and nutritious food [1]. While a more systematic consideration of urban food systems will naturally focus attention on the downstream portions of food value chains, helping to enhance their productivity and competitiveness, to improve both the efficiency and sustainability of urban food systems, significantly greater investments in wholesale marketing and distribution systems, food quality and safety, transport and logistics, and improved food waste management must occur in parallel.

Food systems

Food systems to cities are a complex combination of activities, functions and relationships. Aragrande and Argenti (2001) describe urban food systems as the complex combination of activities (production, handling, storage, transport, process, package, wholesale, retail) operated by a myriad of dynamic agents (actors) that enable cities to meet their food requirements [7].

FAO (2013) consider food systems to encompass all the people, institutions and processes by which agricultural products are produced, processed and brought to consumers [8]. This also includes all the public officials, civil society organisations, researchers and development practitioners who design the policies, regulations, programmes and projects that shape our food system. Every aspect of the food system influences the availability and accessibility of diverse, nutritious foods and thus the ability of consumers to choose healthy diets. However, the linkages from the food system to nutritional outcomes are often indirect, mediated through incomes, prices, knowledge and cultural factors. Furthermore, if the food system is to be both efficient and sustainable, the many actors participating in the many activities to bring food from the paddock to plate require infrastructure, facilities, services and both formal and informal

regulations to govern their business decisions [9]. Because of the complexity of the system, the number of actors and the relationships between actors, where each actor influences and in turn is influenced by other actors, a holistic systems-based approach is required.

According to the methodology and operational guide of the FAO [7], an urban food system can be divided into two main subsystems: (i) food supply to cities, and (ii) food distribution within the urban area. The food supply to cities subsystem includes all those activities that generally take place outside the urban area: production (which includes urban agriculture), storage, marketing, processing and the transport of food to the urban area (either to a wholesale market, to food processors or directly to institutional users). The urban food distribution subsystem consists of all those activities required to distribute food within urban areas. These range from wholesale markets to intra-urban transportation to formal and informal retailing.

However, the primary driving force in any food market is the consumer [10]. Income growth, lifestyle changes brought about by urbanisation and the changing structure of the family are resulting in significant dietary changes worldwide. With the increase in consumer purchasing power and the increasing opportunity cost of time to prepare food, the demand for high value ready-to-eat and ready-to-heat food products is expanding. In parallel, the consumption of coarse grains, roots and tubers are decreasing with a commensurate increase in the consumption of higher value food products including meat, dairy products, fats and oils, and in most markets, fresh fruit and vegetables [11]. However, the growth in the consumption of more convenient, highly processed food is of concern, for the increasing consumption of sugar, saturated fat and salt is known to contribute to health problems like obesity, type 2 diabetes, hypertension and other diet-related non-communicable diseases [12]. Addressing obesity and other non-communicable food related diseases is an urgent and immediate issue [11], for today, six of the top eleven diseases affecting mankind are diet related [2].

From food systems to supply chains

To understand food systems and their impact on society and the environment one needs to embrace the concept of food supply chains. A food supply chain describes the means by which food gets from the paddock (or padi) to plate, including who is involved and how these processes are structured [13]. Simplistically, food producers transform food production inputs into basic foodstuffs which are either consumed or transferred to food processors, institutional users and market intermediaries for distribution to consumers. In the process, the supply chain produces numerous social and environmental impacts, which, in turn, are influenced by numerous environmental and social factors. Collectively, all of these elements working simultaneously and together comprise a food system.

Globally, food systems are highly differentiated, even within countries and territories [13]. Food supply chains vary depending on geography, environment and the socio-economic characteristics of producers, market intermediaries, food processors and consumers. Food supply chains are linked to and influenced by market systems, the political system, the natural environment, farming systems, infrastructural systems, legal and regulatory systems, the financial system, global trade systems, social systems and many other subsystems [9].

World Bank/FAO recognise three types of food systems in urban and peri-urban areas: (i) the traditional food system; (ii) a rapidly emerging modern and globalised food system; and (iii) an informal food system, which caters mostly to those people residing in the informal, low income settlements [1]. All three systems co-exist to varying degrees in most cities.

3.1 The traditional food system

Traditional urban food systems are characterised by vibrant urban wholesale markets that are connected to rural areas through a diverse group of rural-based traders including collector agents, aggregators and assemblers [1]. Terminal wholesalers in larger urban centres service a diverse range of retailers, restaurants and food service operators. Located in dedicated structures or in open markets, wholesale markets are generally operated by public or private entities that manage the space, oversee and regulate the market, and collect fees. Wholesalers receive food from a variety of sources, including smallholder producers, farmer cooperatives, rural based traders, other regional wholesalers and importers.

Open or wet markets, together with small, independent family-run stores, represent the two main retail options for urban consumers in the traditional food system [1]. Open markets generally involve the retail sale of fresh food in covered, open buildings or open-air stalls. They are typically managed by public authorities such as municipalities or public-private companies, who collect fees from vendors for the rental of space, garbage disposal, utilities, security and facility maintenance. In most of the transitional economies, these traditional wet markets are the dominant actor in promoting the sales of staple foods, fresh fruit and vegetables, fresh meat and fish. Open markets appeal to urban consumers for many reasons including: the ability to buy fresh produce (without refrigeration); proximity to the home or office; lower prices; the ability to bargain on price; knowledgeable and personalised service; social engagement and trust; and particularly for meat products, the ability of local vendors to assure the consumer that the product will satisfy any cultural or religious needs [14]. However, the majority of traditional retail markets are wet and dirty, smelly, congested and over crowded, poorly ventilated and often unsafe.

Wet markets are so described because of the frequent use of water to rehydrate foods (and floors) to keep them clean and moist. The increased humidity and lower temperature enables the food to stay fresh for longer. However, in the absence of appropriate waste disposal and the lack of potable water, the frequent application of water may lead to the contamination of the products by a number of pathogens including *Escherichia coli, Salmonella* and *Shigella.* In those markets where livestock and poultry continue to be slaughtered, the separation of live animals and raw meat is often minimal and there are seldom any refrigeration facilities. Similarly, the proximity of fresh fruit and vegetable retailing to the fresh meat and fish sections greatly increases the possibilities of cross contamination, which can present a serious threat to human health.

The second mode of retailing are the small informal, low cost retail outlets that generally maintain low inventories and usually pay no taxes or license fees [1]. They generally sell a wide variety of packaged food products and a limited selection of fresh produce. For consumers, the main benefits are the convenient location; low prices; the availability of credit; personal service; flexible hours; easy return and exchange systems; and the ability to respond flexibly to consumer demand – to sell, for example, one egg or a dozen eggs depending on the consumer demand and ability to pay.

3.2 The modern food system

Modern urban food systems are generally characterised by extended international supply chains that source food products from large corporate food producers and manufacturers through integrated cold chains, state-of-the-art logistics and embedded quality assurance systems. In urban areas, food products are distributed to consumers through a variety of modern retail outlets (including convenience stores, supermarkets, hypermarkets and e-commerce) and food service outlets (including the multi-national fast food chains). Local government and institutional procurement (e.g. schools, hospitals, offices, prisons) may also play a major role in the modern food system [1].

Wholesale operations tend to be more specialized than those found in traditional food systems and usually operate on a much larger scale [1]. Often acting as category managers, wholesalers transact with global commodity suppliers under quality assured supply contracts to ensure the year-round availability of fresh produce which will meet the quality expectations of downstream customers, including an evolving set of value driven preferences, which include health and wellness, social and environmental impact and animal welfare. Through the use of preferred supplier systems and integrated logistics, quality can be maintained and transaction costs reduced, with the cost savings passed onto consumers in the form of more competitive prices.

Modern retailing comes in a variety of forms and scales. Modern grocery retailing is generally a self-service format, appreciated for its competitive prices; attractive store layout; range of products; quality of products; convenience (include car parking); comfortable, safe and hygienic shopping environment; and the availability of additional services [14]. However, modern retail is also diversifying with a variety of new formats emerging including small grocery stores in service stations, mini-markets and specialist retail stores [1]. Furthermore, the rapid development of online sales is changing how shoppers interact with modern retail stores. Most of the modern retailers now offer a “click & collect” option, whereby customers shop online and either pick up their items at a nearby store or opt to have their purchases delivered directly to their home [15].

3.3 The informal food system

The informal food system caters predominantly to the urban poor through informal street food vendors and restaurants that are not generally registered businesses [1]. These businesses are largely cash-based and characterised by small volume transactions. Food products are generally purchased from wholesale or retail markets in the traditional system.

Informal street vendors or hawkers sell the majority of the food consumed by the urban poor, whether through small retail stores or roadside kiosks, stands and pushcarts [1]. They operate primarily in the open air in makeshift structures. As they seldom pay rent and are not registered, they are often subject to harassment by law enforcement officers.

In most cases, informal street vendors offer a limited range of fresh food items and an even smaller range of safe, healthy, nutritious processed food products [1]. While many street food vendors are aware of the desired hygiene practices, their ability to provide safe food is limited by daily exposure to health hazards arising from poor sanitation, poor waste collection and limited access to potable water.

In addition to the retail purchasing of food, many urban households are supported by their rural-based families [1]. While some households are able to produce a proportion of their own food, others may receive food at subsidised prices from government managed stores, or food handouts through various social safety nets supported by both government and NGOs.

Challenges

Across the globe, the key issues associated with increasing urbanisation are remarkably similar, even although the main drivers and priorities may differ. However, from a supply chain perspective, the key institutional challenges are associated with:

The exclusion for smallholder farmers

As the urban population continues to expand agricultural productivity will need to improve. Among the 1.3 billion smallholder farmers [16], most of whom reside in the developing countries, significant improvements in yields are expected to arise from the more widespread adoption of improved technology. However, despite the opportunities, the high cost of and limited access to inputs (including credit), limited access to output markets, poor infrastructure, price instability and issues associated with land tenure continue to discourage smallholder farmers from adopting new innovations [17]. Furthermore, there is an increasing recognition that if smallholder farmers are to increase productivity, they must be linked to markets [18, 19].

Indeed, FAO (2009) suggest that facilitating market linkages should receive as much attention as enhancing production [18]. With downstream customers becoming more demanding of quality, food safety and convenience, Shepherd (2007) identifies a number of alternative routes to market [20]. However, irrespective of the mode chosen, if smallholder farmers are to engage meaningfully with downstream customers, there is a need for smallholder farmers to collaborate. It is only through the formation of collaborative marketing groups that smallholder farmers are able to gain access to the resources that they need to engage meaningfully with institutional buyers, but also to deliver the desired quantities and quality of products, reliably and consistently [21].

Food marketing and infrastructure

In most of the transitional economies, the lack of poor quality roads makes transport and logistics both difficult and expensive. For many smallholder farmers, multiple modes of transport are often required to bring the produce to roadside collection points, which not unexpectedly, results in considerable damage to the product and often the need to both regrade and repack the produce. In other instances, the costs of transport are increased by the need to pay various taxes, both formal and informal, which not only have a direct negative impact on product quality, but which ultimately influence the price that consumers need to pay.

Within the cities themselves, the distribution of food is often negatively impacted by the location of the wholesale markets and traffic congestion. While efforts by municipal authorities to limit the hours when heavy vehicles can enter the city may reduce congestion, in the absence of any refrigerated transport, the need for trucks to park and wait can dramatically accentuate the postharvest deterioration of product in the last mile. Likewise, in the absence of any reliable

energy infrastructure, market intermediaries are unable to operate any refrigerated cool storage facilities.

Regrettably, within the community at large, there is a common perception that market intermediaries are extracting inordinately large profits from the wholesale distribution and marketing of food. However, there is mounting evidence to demonstrate that wholesale margins are significantly lower than retail margins. Furthermore, wholesalers perform an important function in the distribution of food. Their primary role is to receive the product from traders (in bulk) and to break that bulk down into quantities that meet the retailers demands. However, wholesalers also perform numerous other value-adding activities including: (i) the creation of assortment; (ii) storage; (iii) after sales service and support; (iv) market intelligence; and of particular importance in many of the transitional economies, (v) wholesalers are the major financiers both for the traders (who must purchase from farmers in cash) and the smaller retailers (who generally pay for the products after they have sold them).

Food safety

In the modern food system, long complex supply chains and logistics systems can greatly elevate the risk of contaminated food being inadvertently distributed if food safety mechanisms are inadequate [1]. While the greatest concern is associated with biological contamination arising from micro-organisms such as *E. coli*, *Salmonella* or *Listeria*, foods may also be recalled because of contamination arising from foreign materials such as plastic and metal, chemical residues - present within the product itself or from accidental contamination with cleaning products, or the failure of food processing companies to declare the presence of potential allergens, including milk, eggs, soy and nuts. While poor food storage and preparation in centralized food processing companies have been linked to many large-scale foodborne illness outbreaks, fresh produce is not immune. Numerous fatalities have been associated with the consumption of organic bean sprouts, papaya and rock melons in Europe, the US and Australia.

So as not to damage their brand, most of the world's major retailers now require their suppliers to operate under one or more third party certified quality assurance systems. However, with consumers now demanding greater traceability and competition intensifying within the sector, standards are rising to include issues such as environmental sustainability, fair trade and equity, animal welfare and social inclusiveness. As most smallholder farmers do not have the resources or the capacity to comply, by necessity, most can only supply the traditional market. Here within lies one of the greatest inequities in the food system, for in the absence of any effective training, monitoring and evaluation, and without improving basic sanitation and handling in the traditional wet markets, the health of many millions of urban consumers is potentially compromised each and every day.

A similar situation exists in the informal food market, where most street food vendors are distributing processed food products or preparing ready to eat meals with little or no training in basic hygiene and limited access to electricity and potable water [5]. Without appropriate monitoring and evaluation, other actors in the food industry may purposefully, but often unknowingly, adulterate food with chemicals to enhance the shelf life (such as formaldehyde), its protein content (melamine) or to improve the physical appearance of the product (lead chromate in turmeric).

At the farm level, a range of factors can lead to food being unsafe, such as naturally occurring toxins in the food itself, contaminated water, unsafe use of pesticides, and veterinary drug residues [22]. Unhygienic handling and poor storage conditions can also cause unsafe food.

Environmental impacts and sustainability concerns

Important debates are currently underway on how best to balance a city's reliance on longer supply chains with the need to reduce energy consumption and the adverse environmental impact of food miles [12]. Evidence is emerging that with the right improvements in transport and logistics technology, long supply chains can lower transport costs and emissions per ton. However, at a local level, investments in new roads and road maintenance and the regular updating and maintenance of vehicles will also reduce the cost of transport and GHG emissions.

Nevertheless, with the increasing incidence of product recalls and food safety scandals, consumers trust in self-regulatory systems and the business ethics employed by many of the large food companies is rapidly diminishing. Consumers around the world have begun to embrace food products that support local food producers. While there are many motivating factors behind the trend, it is believed that the demand for local food is largely being driven by anti-globalisation sentiments. Locally sourced foods are perceived to offer consumers fresher produce, clear provenance, and the ability to support the local economy and the livelihoods of smallholder farmers.

Food packaging is also high on the agenda. While there is the desire to use more packaging as a means of protecting the product from damage and extending shelf-life - and thus reducing food waste - there is an urgent need to reduce the use of plastics. Plastic is an enormous problem in the fresh produce industry, for not only is plastic an affordable and effective method of packaging fresh fruit and vegetables, but considerable technological advances have been made in active and intelligent packaging which moderate the exchange of gases to prolong shelf-life, but also communicate with consumers to minimise early disposal and excessive purchasing [23].

Other environmental concerns include groundwater pollution and the pesticide risks associated with the intensification of agricultural production [6]. In the horticulture sector, the loss of habitat and pollution from agrochemicals is affecting pollinators and the natural enemies of pests, reducing the value of important ecosystem services [24]. Eutrophication, arising primarily from the excessive application of nitrogen fertilisers, is negatively impacting fresh water quality.

With urbanisation comes increasing conflict over both land and water. Given that over 70 percent of the world's freshwater is currently devoted to agricultural production, conflict over water from residential and industrial users and the environment itself will negatively impact the global food system [2]. Increasing productivity will also depend on healthy soil, but close to one quarter of all agricultural land is already degraded.

Food waste

Approximately one third of the food produced for human consumption is either lost or wasted [22]. Not only does this result is the wastage of vast amounts of natural and human resources, but the 1.3 billion tonnes of food waste, in the process of decomposition, makes a significant and unnecessary contribution to GHG emissions.

In the transitional economies, most of the food losses and waste are attributed to financial, managerial and technical limitations in harvesting techniques, the lack of suitable storage and cooling facilities, poor infrastructure, poor packaging and weak marketing systems [22]. However, in the industrialised countries, most of the food is wasted at the consumer stage, which implies that a significant proportion of the food discarded is still fit for human consumption. Regrettably, much of the food is wasted because it fails to meet the high aesthetic quality standards established by many of the major food retailers, whereas at the consumer level, poor purchase planning and expiring 'best-before-dates' can result in large amounts of food waste. While some of the reject product is sold to food processors or as animal feed, as it is not always financially viable, considering the lower prices in these sectors, much of waste product is simply dumped as landfill.

With increasing urbanisation, poverty and malnutrition is shifting from the rural sector to an urban environment. Here it is important to understand that food insecurity is more often a question of access to food (purchasing power and prices of food) rather than the availability of food. While improving the efficiency of food supply chains may help to bring down the cost of food to the consumer, it is equally important to investigate strategies to recapture, recycle and redistribute food that would otherwise be discarded. In response to public demand, most retailers now offer misshapen vegetables and blemished fruit as part of their basic range, albeit at a discounted price.

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A New Technology of Jute Geotextiles Developed for River Bank Protection in Different Geographical Places of Bangladesh

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Abstract

Jute geotextiles have shown a great potential for numerous applications including civil engineering, agriculture, construction, drainage and river bank protection. The samples of jute geotextiles were supplied by Bangladesh Jute Mills Corporation (BJMC). The samples were treated with bitumen, natural additive, chemicals (resin) and copper-sulphate in the Pilot Plant Processing Division of Bangladesh Jute Research Institute (BJRI). Physical and mechanical properties of jute geotextiles (JGT) were measured at the Testing Laboratory of BJRI. It was found that tensile strength of natural additive treated jute geotextiles increased up to 38 % whereas the tensile strength of bitumen treated jute geotextiles may increase up to 14% depending on the treatment conditions. It was noted that tensile strength of the copper sulphate and resin treated jute geotextiles was found insignificant. The treated jute geotextiles were used in the river bank protection in five sites of Bangladesh with a view to control soil erosion. For river bank protection 19% cost reduction was observed from JGT with compared to man- made geotextiles. It was found that natural soil filter (filter cake) was partially formed after six months of its installation, no distress was found in the river bank after fifty four months application of GJT at Hatirjeel project, Dhaka. Treated JGT was observed to be effective in the protection of river bank for different geographic regions with different type soil. So, JGT can be effectively used for river bank protection instead of synthetic geo-textile in case of moderate to mild river.

Keywords: Jute geotextiles, Natural additive, Bitumen, Copper sulphate, Tensile strength, Life Span

1 Introduction

Geotextiles are permeable fabrics, association with soil, have the ability to separate, filter, reinforce, protect, or drainage. Work of geotextiles originally began in the 1950s with R.J. Barrett using geotextiles behind precast concrete seawalls, under precast concrete erosion control blocks and in other erosion control situations. He used different styles of woven monofilament fabrics. BJRI scientist, Dr. A. B.M Abdullah started research work on jute geo-textile from 1986 and jute geo-textiles were treated by bitumen only since 2011.

Geotextiles and related products have many applications and currently support many civil engineering applications including roads, airfields, railway, roads, embankments, retaining structures, canals, dams, bank protection, coastal engineering and construction site. Usually geo-textiles are placed at the tension surface to strengthen the soil. Geotextiles are also used for sand dune armoring to protect upland coastal property from storm surge, wave action and flooding. A large sand-filled container (SFC) within the

dune system prevents storm erosion from proceeding beyond the SFC. Using a sloped unit rather than a single tube eliminates damaging scour.

Geo-textiles are typically made from polymers (polypropylene or polyester) and may be knitted, woven, or heat-bonded, depending on the application. They are extremely strong and durable, and also have permeable traits to allow water to pass.

There are certain associated problems as well. There is slow but sure depletion of the valuable source warranting its controlled use. There is thus unabated rise in prices of the raw materials as a result which in turn makes geo-textiles expensive. It has been proven through a number of field trials that the DW type Jute geotextiles is applicable for rural road construction and river bank protection (Khan, 2009). Therefore, there is a need for search for eco-friendly, renewable, abundantly available and economically viable alternatives.

Jute and jute products are not only environment friendly but also their wider application protect environmental degradation and even soil and climate deterioration reducing carbon-foot print and water-foot print. Jute Geotextiles is a green technology currently drawing global attraction as regard rapid climate change and global warming is focused as major challenge of 21st century for sustainable and eco-friendly development (Abdullah, 2016).

Natural fibre for geotextiles

A fibre would be suitable for manufacturing geo-textiles when (a) It possesses suitable mechanical properties and in some cases along with good hydraulic properties and (b) It is reasonably resistant to bio-degradation (Basu et al., 2009). Natural fibres can be of vegetable, animal or mineral origin. Geotextile made if natural fibres can compete with synthetic material in many applications because of their lower price, "environment-friendly" character and superior mechanical properties. The different characteristics of the various natural fibres used in geo-textiles make certain types more suitable than others geo-textiles in specific applications. For instance, geo-textiles made of softer fibres such as jute may have a shorter lifetime than fabrics made of hard fibres such as coir because of a difference in their biodegradable properties. The important vegetable fibres which are either in use or have potential to be used as raw material for geo-textiles are jute, coir, sisal, flax, kenaf, abaca, pineapple etc.

Jute geotextiles

Jute is composed of cellulose (63%), hemicelluloses (20-22%), lignin (12-14%), fats and wax (0.4-0.8%), mineral materials (0.6-1.2%), tannin and colouring pigments. Jute is biodegradable natural fibre with high initial strength and excellent drapability, and from a polyfunctional point of view, its application in the form of geo-textile material in various erosion control measures is clearly very significant. From different reports and articles, it is clear that jute has better mechanical properties (desirable for reinforcement application) and more hygroscopic (desirable for drainage) than the conventional polypropylene and polyester fibres (generally prepared from recycled polymers) used for manufacturing geo-

textiles. Biodegradability is considered by some as disadvantage. This is to be borne in mind that all geotextiles act as catalyst the process of improving engineering properties of soil. An effective life span of two season cycles is found to be sufficient for natural consolidation of soil know as "filter cake" formation from extensive laboratory tests by leading academics and field trials. Bioderagadability of jute Geotextiles (JGT) is, therefore, not a discouraging factor.

In this research work, the hessian jute fabrics were collected from Bangladesh Jute Mills Corporation (BJMC). These jute fabrics were treated with different chemical solutions under room temperature in order to increase their mechanical properties. Subsequently, a comparison was made between their physical and mechanical properties of these treated jute fabrics generally known as jute geotextilles (JGT). These jute geotextilles were potentially used to protect the river embankment. Therefore, the main objective of the present article is to find out the suitable chemicals to treat the jute geotextilles and analyze the mechanical properties of the treated jute geotextilles.

2 Materials and Methods

2.1 Materials

Double Warp (DW) plain weave Jute Geo-textile of 627 gsm was supplied by Bangladesh Jute Mills Corporation (BJMC) for JGT field trial application. Bitumen, copper sulphate, natural additives (Latex Solution and *Diospyros embryopteris Pers)* and other chemicals (resin) were used in this study. This study was conducted at Hatirjeel project, Dhaka which was implemented by Special Work Organization (SWO) of Bangladesh Army.

2.2 Treatment of Jute geotextiles

The collected jute fabrics were treated with the above mentioned chemical using suitable material and liquor ratio by using padding machine. Subsequently, the treated samples were dried in open air and packed.

2.3 Thickness and mass per unit area (g/m^2) determination of the treated jute geotextiles

Thickness of the treated jute geotextiles was measured by digital thickness gauge. The mass per unit area of the jute geotextiles was measured based on ASTM standards. Sample dimensions of 30 cm × 30 cm were cut for conditioning and the weight of the conditioned sample was measured on a precision balance. An average of five readings for each sample was taken for determining the mass per unit area (g/m^2) of jute geotextile sample.

2.4 Determination of tensile properties of the treated jute geotextiles

Tensile strength and elongation at break of the treated jute geotextiles were determined in both warp and weft directions using tensile strength tester according to ASTM standards. All the samples have been tested in standard atmospheric conditions (21±2) º C and 65 ± 5 % relative humidity. An average of five readings for each sample both in Warp and Weft directions was calculated.

2.5 **Location**: In this study firstly natural additive treated JGT sample of 200 metre was implemented at Hatirjeel project, Dhaka by Special Work Organization (SWO) of Bangladesh Army. Bitumen treated woven JGT of 627 gsm was used in Pathoraj river bank, Panchagarh in July, 2011 and in MBR channel river bank, Gopalganj in 2013. Natural additive treated JGT of 627 gsm was used in Gorai river bank, Baliakandi, Rajbari in June 2013 and bitumen, resin, copper sulphate and natural additive treated JGT of 627 gsm were used in Ghagot river bank adjacent to Rangpur Cantonment, Rangpur in May, 2014. Executive Agencies of this JGT are BWDB and Bangladesh Army

2.6 **JGT used in River Bank Protection** was designed by Bangladesh Water Development Board (BWDB).

3 Results and Discussion

The different physical and mechanical properties were tested for untreated and different treated Jute geotextiles. Total amount of jute geotextiles treated in BJRI during last four consecutive years were shown in Table 1.

Table 1: Jute Geotextiles processed by BJRI (Various treatments

Year	Jute fabric processed (yards)
2011	12000
2012-2013	12500
2013-2014	11500
2014-2015	9500
Total	46000

Yarn densities of different jute fabrics used as geotextiles were shown in Figure 1.

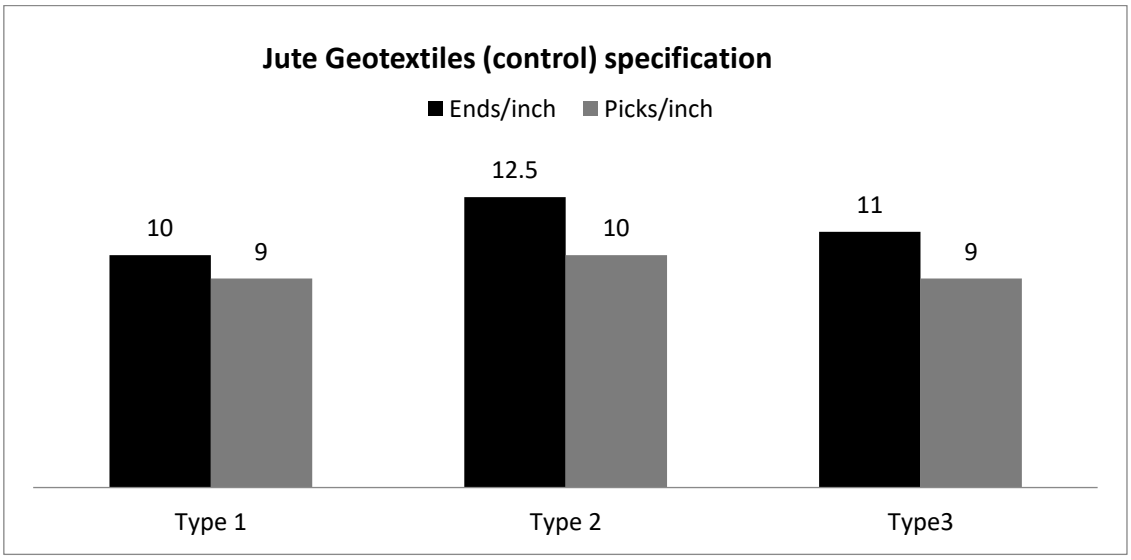

Fig. 1: Yarn densities of different jute fabrics used as geotextiles

The mass per unit area and thickness of jute geotextiles are shown Table 2. From the Table 2, it was revealed that mass per unit area (g/m^2) and thickness has changed significantly after treating the jute geotextiles with different chemicals.

Table 2: Typical gm/square meters and thickness of Jute geotextiles

Samples ID	Gram/square metre (g/m^2)	Thickness (mm)
Untreated/Control	627	1.45
Bitumen treated	950	1.77
Chemical (resin) treated	660	1.69
Natural Additive treated	675	1.69
Copper sulphate treated	665	1.61

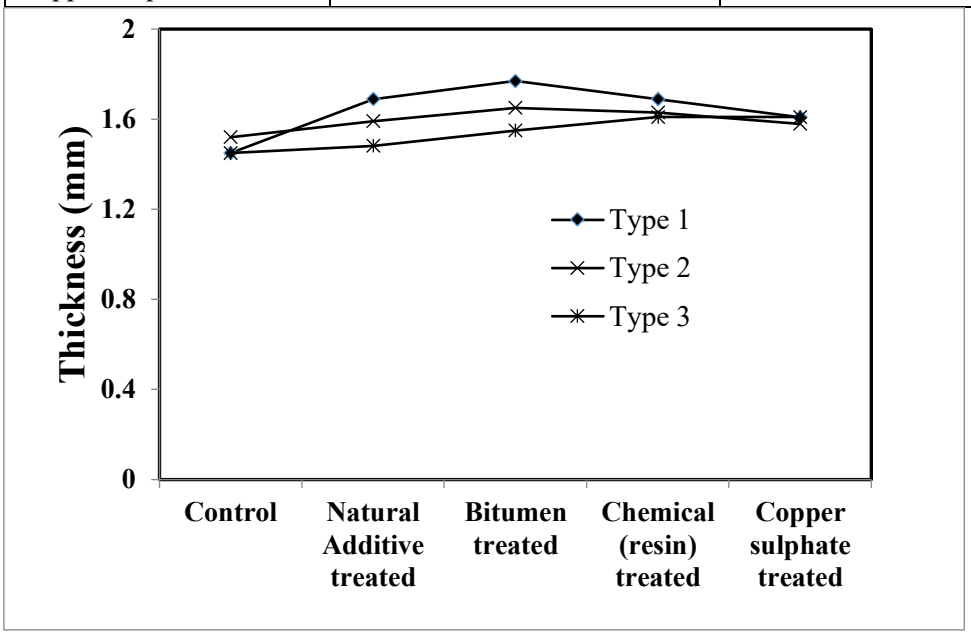

Fig. 2: Thickness variation of different treated and untreated jute geotextiles

The tensile strength and elongation at break of jute geotextiles in both warp and weft directions are illustrated in Table 3.

Table 3: Typical tensile strength and elongation percentage of Jute geotextiles

Sample ID	Tensile strength (lbs)		Elongation at break (%)	
	Warp wise	Weft wise	Warp wise	Weft wise
Untreated/Control	210	165	17.50	20.85
Bitumen treated	240	180	21.50	20.00
Chemical (resin) treated	212	170	13.75	10.00

Natural Additive treated	290	229	25.75	23.00
Copper sulphate treated	230	160	14.00	23.75

From the Table 3 it was revealed that tensile strength in warp direction of natural additive treated jute geo-textile was increased significantly (up to 38 %), whereas the tensile strength of bitumen treated jute geotextile was increased up to 14% depending on the treatment condition. Similarly, the tensile strength in weft direction of natural additive treated jute geo-textile was increased up to 39 %, and the tensile strength of bitumen treated jute geotextile was increased up to 9 %. It is noted that tensile strength of the copper sulphate and chemicals (resin) treated jute geotextiles has not shown any significant improvement.

The graphical presentation of tensile strength in both warp and weft directions are depicted in Figures 3 and 4.

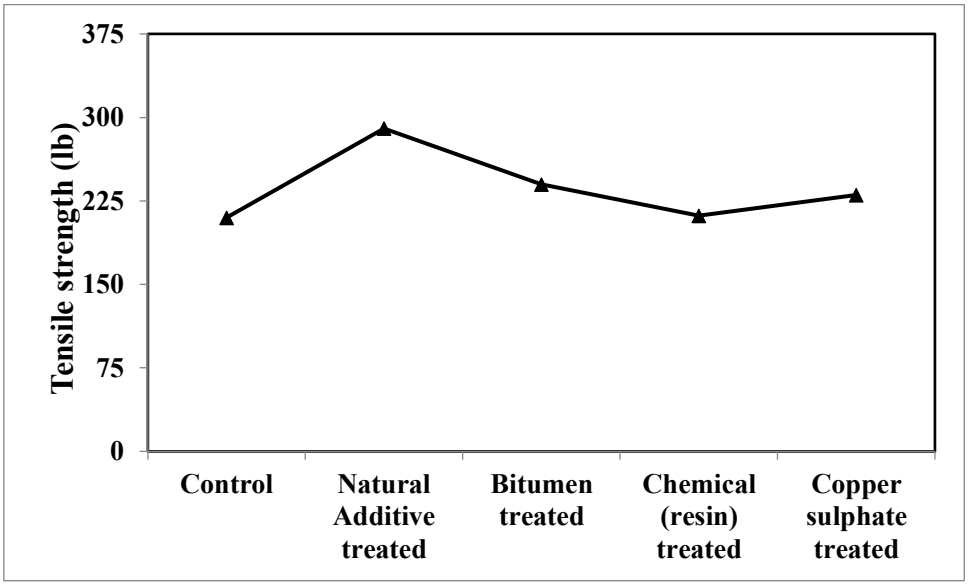

Fig. 3: Warp wise tensile strength of different treated and untreated jute geotextiles

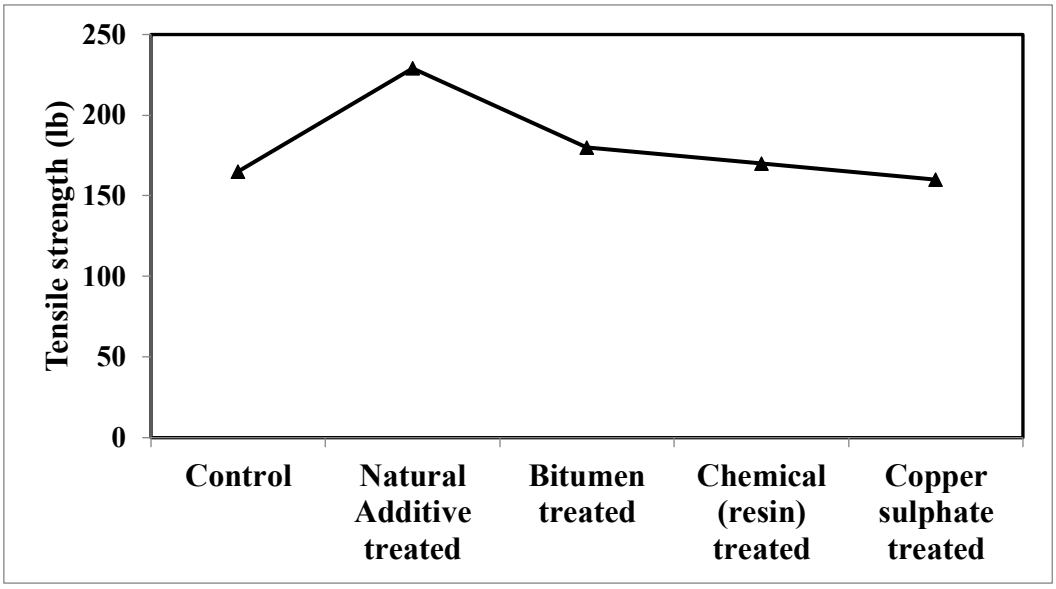

Fig. 4: Weft wise tensile strength of different treated and untreated jute geotextiles

In general, it has been observed that the tensile strength in the warp direction was much higher than the tensile strength in the weft direction due to the better quality yarn used in the geotextle sample. However, the maximum magnitude of the tensile strength in the warp direction was obtained in natural additive treated jute geotextiles. The graphical presentation of elongation at break in both warp and weft directions are also shown in Figures 5 and 6.

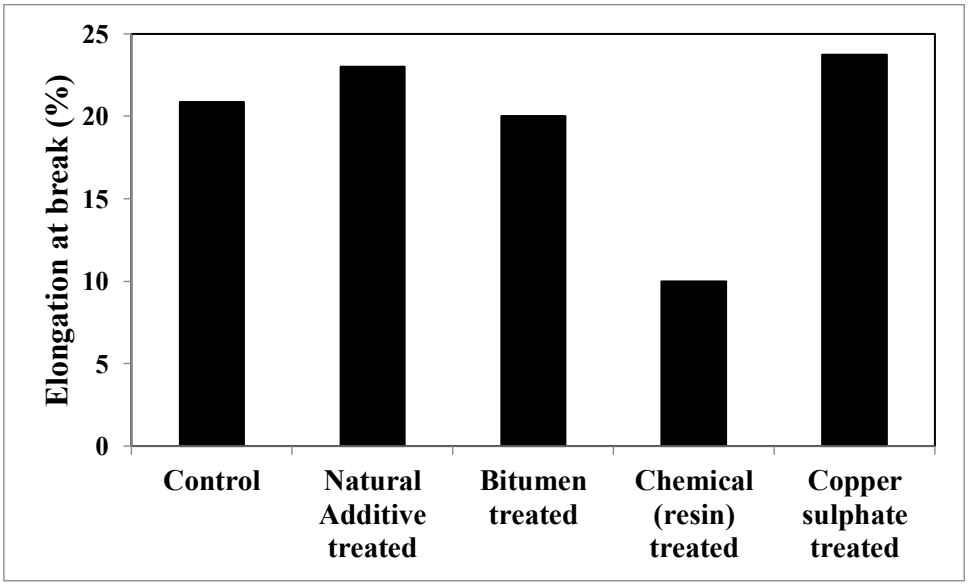

Fig. 5: Warp wise elongation percentage of different treated and untreated jute geotextiles

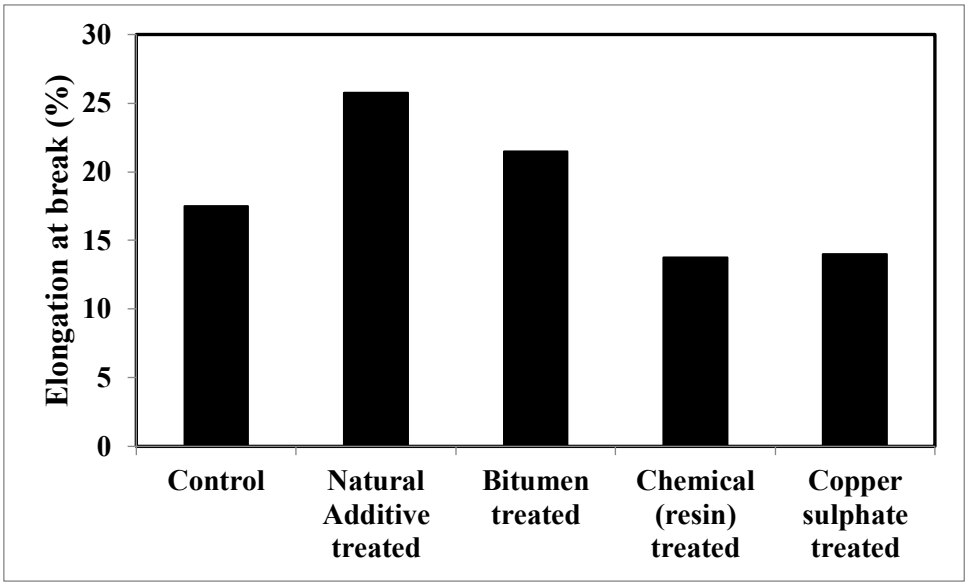

Fig. 6: Weft wise elongation percentage of different treated and untreated jute geotextiles

The elongation at break in warp direction was also increased significantly in natural additive treated jute geotextiles. A comparison between the longevity of untreated (control) and different treated Jute geotextiles are shown in Table 4. From the Table it is observed that in general, longevity of different treated Jute geotextiles has increased significantly than that of untreated (control) Jute geotextiles. Specially, natural additive treated jute geotextiles exhibit the best performance in comparison to other treated jute geotextiles.

Table 4: Longevity of untreated (control) and different treated Jute geotextiles

Type A	Duration (Months)	Type B	Duration (Months)	Type C	Duration (Months)	Hygienic	Environment friendly
Control 1	3	Control 2	1-3	Control 3	<3	Hygienic	Eco-friendly
Natural Additive A1	36-42	Natural Additive A2	36-42	Natural Additive A3	36-42	Hygienic	Eco-friendly
Bitumen B1	36	Bitumen B2	36	Bitumen B3	36	Non Hygienic	Non Eco-friendly
Chemical (resin) C1	9-15	Chemical (resin) C2	9-15	Chemical (resin) C3	9-15	Non Hygienic	Non Eco-friendly
Copper sulphate treated D1	6-12	Copper sulphate treated D2	6-12	Copper sulphate treated D3	6-12	Hygienic	Eco-friendly

The evidence of longevity of natural additive treated jute geotextiles has been shown in Figures 7-10.

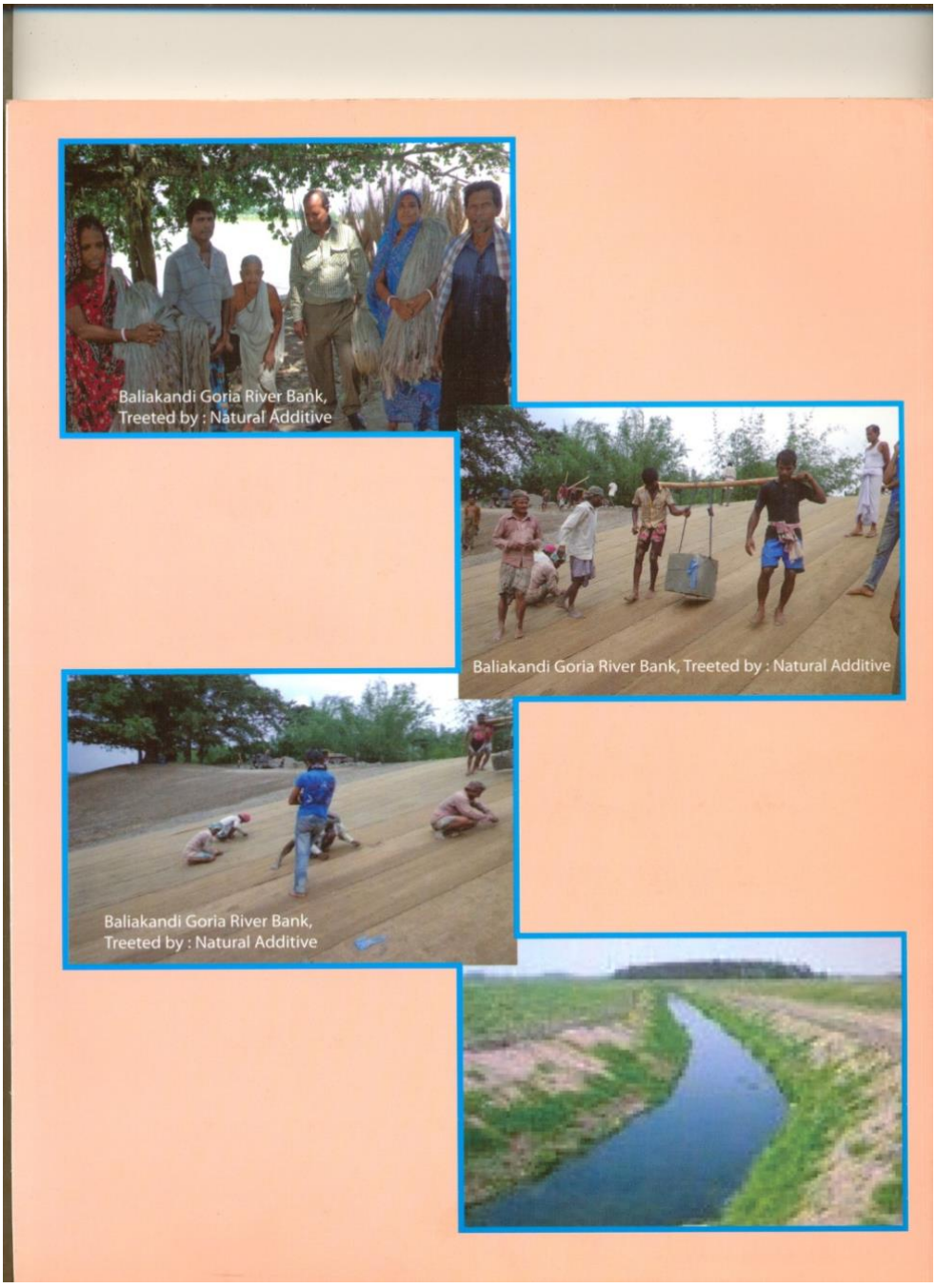

Fig 7: Various activities of Natural Additive treated JGT and other types of Treated Jute Geotextiles at Gorai river bank site, Baliakandi, Rajbari during the year 2013

Fig 8: Application of Natural Additive treated Jute Geotextiles at Gorai river bank, Baliakandi, Rajbari (Visited on 30th April 2016)

Fig 9: Application of Natural Additive treated Jute Geotextiles at Ghaghot river bank adjacent to Rangpur Cantonment, Rangpur (Visited on 25th May 2016)

Fig 10: Application of Natural Additive treated Jute Geotextiles at Ghaghot river bank adjacent to Rangpur Cantonment, Rangpur (Visited on 25th May 2016)

4 Conclusions

Jute geotextile is one of the most important diversified jute products with a potentially large scale application. It can have several applications as: soil erosion control, vegetation

consolidation, agro mulching, reinforcement, and protection of riverbanks and embankments, land reclamation and in road pavement construction. The demand for jute geotextiles is increasing in various parts of the world. However, absence of adequate awareness and standards and specifications seem to be affecting the possible expansion of the market. Jute geotextiles would need to meet to satisfy environmental and geotechnical engineers. The obvious results in erosion control were generally known, but it was interesting to note that composite products involving jute in combination with synthetics, or jute together with coir, can offer optimum solutions in other areas. Some applications are clearly suited to jute, but the material characteristics need more elaboration. Jute geotextiles were treated with bitumen, chemicals (resin), copper sulphate and natural additive. The physical and mechanical properties of untreated and different treated Jute Geotextiles were determined to evaluate the performance of Jute geotextiles.

- From the study it was revealed that tensile strength in warp direction of natural additive treated jute geo-textile were increased up to 38 %, whereas the tensile strength of bitumen treated jute geotextile were increased up to 14% depending on the treatment condition.
- It is noted that tensile strength of the copper sulphate and other chemical (resin) treated jute geotextiles has not shown any significant improvement.
- The treated jute geotextiles were used in the construction of river embankment in different places of Bangladesh with a view to control soil erosion.
- The life span of the used jute geotextiles was found satisfactory.
- For river bank protection works 19% reduction in initial cost reduction from Man-made Geotextiles.

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Development of Agribusiness Trade and Finance Linking with Farmers[i]

Dr Sharif Uddin Ahmed Rana, Dr. Sharifah Sabrina , Nazmul Hossain and Rob Enderle

Abstract

Agriculture is a major source of livelihood for the majority of poor people living in rural areas in developing countries as well as in Bangladesh. A key challenge for the majority of these farmers is access to market and also finance. Lack of linkage with market and access to finance are key impediments to farmers in improving the efficiency of their productions and adopting better technologies. On the other hand, agribusiness is the off-farm link in agro-food value chains. It provides inputs to the farm sector, and it links the farm sector to consumers through the handling, processing, transportation, marketing, and distribution of food and other agricultural products. Thus, there are strong synergies between agribusiness and the performance of agriculture for development. Dynamic and efficient agribusiness spurs agricultural growth. A strong link between agribusiness trade and finance with smallholder farmers can contribute to increase the agricultural productivity ensuring the farm-gate fair price. The food systems are undergoing rapid transformation. Increasing concentration in processing, trading, marketing and retailing is being observed in all regions of the world and in all segments of production-distribution chains. The traditional way in which food is produced, without farmers' having a clear idea in advance of when, to whom and at what price they are going to sell their crops, is being replaced by practices more akin to manufacturing processes, with far greater coordination between farmers, processors, retailers and others in the supply chain. Farmers increasingly produce to meet the requirements of buyers rather than relying on markets to absorb what they produce. However, agribusiness trade and finance are not well-linked with small holder farmers to enable good environment for transforming in commercial agriculture in Bangladesh. The paper explores the problems for linking farmers with agribusiness trade and finance and how the linkages can gradually improve the agribusiness sectors in Bangladesh

1. Introduction

In general terms, agribusiness can be understood as the collective business activities performed "from farm to fork" (Konig, Da Silva and Mhlanga 2013). However, agribusiness is an evolving term that has been expanded and complemented with a variety of names, such as agro industrialization (Cook and Chaddad 2000) and agriceuticals (Goldberg 1999). These definitions share an emphasis on the interdependence of the various sectors of the agri-food supply chain (Ng and Siebert 2009). The pioneers of the agribusiness concept, John H. Davis and Ray A. Goldberg, define agribusiness as "the total sum of all operations involved in the manufacture and distribution of farm supplies; production operations on the farms; and the storage, processing, and distribution of farm commodities and items made from them" (Davis and Goldberg 1957). Agribusiness can therefore be defined as a set of economic activities in which the agricultural sector overlaps with the manufacturing, services, and other economic sectors.

Traded agribusiness products rely on services, such as transport services, financial services, and communication services, and involve at least basic manufacturing or processing steps, such as simple treatment and/or packaging of the good, supported by other sectors such as water and electricity. Because every good or product requires different inputs and follows a different

production process, it involves the different sectors to different extents. Therefore, traded agribusiness is a subset of agribusiness linking with farmers. It lies close to the intersection of all sectors, but cannot be exactly determined, given its links with other activities of the economy.

Agribusiness involves all agricultural business activities from production to consumption, including the supply of agricultural inputs as well as the processing and distribution of agricultural products. In developing countries and emerging economies, agribusiness is one of the main generators of employment and income. Over half of the exported industrial products from developing countries depend on agribusiness services. Successful trade at all levels – international, regional and local – is therefore key for agribusinesses to prosper the small holder farmers.

2. Market Linkage with Farmers

Market linkages are presented according to the ways in which farmers are linked to the buyers. The examples provided are used to draw lessons about the various approaches and their likelihood of success. Both negative and positive aspects of the different approaches are therefore considered. The main advantages and disadvantages of different types of linkage are summarized in Table 1.

Types of linkage can be categorized in various ways. The following typologies are analyzed to know market linkage with farmers:

- Farmer to domestic trader;
- Farmer to retailer;
- Linkages through a leading farmer;
- Linkages through cooperatives;
- Farmer to agro processor;
- Farmer to exporter;
- Contract farming.

These categories do not, of course, represent the whole range of market opportunities available to farmers. In some countries government marketing boards continue to play an important role. Purchases by government institutions, such as the military and hospitals, can be an important market and several countries implement school-lunch programs that provide direct-sale opportunities for rural producers. Furthermore, the above categories are clearly not always mutually exclusive. Exporters can also be agro processors. Agro processors can also run contract farming operations. Retailers may buy from farmers through traders. What is characteristic of almost all of the linkages described, however, is that they form clearly identified chains and often involve close relations between the participants.

Spot markets such as wholesale markets, commodity exchanges and auctions, are not a characteristic of linked markets. Nevertheless, it should be noted that simple activities to link farmers with traders supplying spot markets, e.g. through bulking-up production for sale, can be very effective.

Table 1: Types of Farmer-Market Linkage

Type of linkage	Collective activity	Advantages for farmers	Disadvantages for farmers
Direct between farmers and traders	❖ Farmers usually act on a one-to-one basis with traders; ❖ May work together informally to bulk-up produce to reduce costs and attract larger traders.	❖Requires high level of trust but such trust likely to ensure long-term sustainability; ❖Formal farmer organizations not usually needed; ❖Traders may (rarely) provide training in production and handling.	❖ May need to accept short-term deferred payment; ❖ Limited access to high-value markets.
Direct between farmers and retailers (including restaurant chains) or their wholesalers	❖May require formal group structure, particularly when buyer does not want to deal with farmers individually.	❖Reliable market at agreed price.	❖ Must meet variety, quality and safety specifications; ❖ Must be able to supply agreed quantities at all times. This may place farmers in conflict with social obligations; ❖ May have to accept deferred payment of up to 90 days.
Farmer to exporter	❖Often involves grouping of farmers. External technical assistance may be required.	❖ Potential high returns if quality can be achieved; ❖ Inputs, technical assistance, etc. may be supplied on credit; ❖ Exporter often provides transport and packaging.	❖ Export markets are inherently risky; ❖ Compliance with standards (e.g. organic; quality and traceability; fair trade) can be problematic, even with technical assistance.
Direct between farmers and agro processors	❖ Farmer groups can bulk-up produce for collection by processor; ❖ Groups can facilitate supply of inputs and provision of technical assistance.	❖ May provide secure market at agreed price; ❖ Offers additional market in addition to fresh market; Inputs, technical assistance, etc. may be supplied on credit; ❖ Processor often provides transport; ❖ Potential for farmers to sell larger volumes.	❖ There may be an inadequate market for the processed products, thus jeopardizing sustainability; ❖ Must meet variety, quality and safety specifications; ❖ Open market price may be higher than that agreed with processor; ❖ Risk of delayed payments.
Formal large-scale contract farming	❖Company may prefer to group farmers, formally or informally, for input and output marketing and extension; ❖External assistance may be needed to support farmer groups.	❖Inputs, technical assistance, etc. may be supplied on credit. In the case of long-gestation crops, such as oil palm, tree crops or sugar, credit is essential and may also be provided to meet subsistence expenses; ❖Crop marketing organized by company.	❖ Companies often require external agency (e.g. bank) to finance credit provision; ❖ Frequent mistrust between farmers and companies and their employees; ❖ Contracted price lower than market price may lead to sales outside of the contract; Difficulties may be experienced if NGO withdraws.

Linkage promoted by leading farmer	❖Farmers usually function as informal group, coordinated by one or a few leading farmers.	❖Farmers have output, and sometimes, input marketing taken care of; ❖Greater negotiation power with larger quantities.	❖ ❖ Leading farmer may pull out of the venture; ❖ Payment may be deferred if buyers defer payment to leading farmer.
Linkages through cooperatives	❖Farmers may link directly with the cooperative or through groups.	❖Inputs, technical assistance, etc. may be supplied on credit; ❖Crop marketing, packaging, grading and storage and, sometimes, processing organized by cooperative; ❖Potential for farmers to sell larger volumes.	❖ Cooperatives often depend on subsidies and external managerial assistance. Commercial activities can collapse when subsidies and assistance run out.

Source: Shepherd, A.W., 2007. Approaches to linking producers to markets - A review of experiences to date, Agricultural Management, Marketing and Finance Service, FAO Rural Infrastructure and Agro-Industries Division, FAO, Rome, Italy.

3. Linking Arrangements between Farmers and Agro-Processors

Service Provision

Most agribusiness companies studied provide a wide range of extension services to farmers. These services include the provision of agricultural inputs such as seeds, fertilizer, agrochemicals, veterinary drugs, artificial insemination, animal feed etc. as well as field preparation services, supply of irrigation water, produce transport etc. free-of-charge or on credit. The private sector is able to take over public extension services to primary producers, provided the agro-business is a profitable enterprise.

Contractual Agreements

Contractual agreements vary from informal - not based on any written document - to formal contracts, which determine prices, quantities, quality standards and services to be provided by the processor. Formal contracts are more common in developing countries. However, there is no evidence that formal contractual agreements are necessary for sound linkages between farmers and buyers. Especially weak contract enforcement and an inefficient jurisdiction system make contractual agreements obsolete. Mutual trust is more important which can be developed through longer –term “fair play” on both sides, reliable and fast payments, reliable and prompt product deliveries. However, a sound understanding of quality requirement, applied methods of quality control, payment terms and expected delivery schedules.

Price Determination

Prices are normally determined by the processor and not by the farmer. In some cases, prices vary from day to day, according to prevailing market prices, in other cases, the processor fixes the price on a seasonal basis which then fluctuate according to market conditions. Traditionally parastatals have fixed prices on a seasonal basis for cash crops especially for export crops in order to buffer farmers from price fluctuations.

Purchasing Arrangements

Methods and practices of raw material exchange can range between simple ad hoc spot market transactions with or without the inclusion of intermediaries or informal supply arrangements to highly managed co-operation such as farming under contract, asset sharing arrangements between farmers and processors or fully vertical integration of producing and processing activities.

Full vertical co-operation

Full vertical co-operation applies to situations where farming and processing are undertaken by the same business entity. The level of co-operation is highest with direct linkages between farming and processing. Examples are found in traditional export crops such as oil palm, cocoa, coffee, tea etc. as well as high value horticultural crops when processing entities secure their raw material supplies through a variety of arrangements.

Asset sharing arrangements

These are an important means to link agro-business and farming. Commitments vary according to equity held by each party and shareholder representation on supervisory boards and within the management of the agribusiness.

Contract farming

Successful agri-businesses have to maintain the volume and regularity of raw material supplies in order to operate at a reasonable proportion of their planned capacity. To achieve this, local companies may enter into formal contracts with wholesale traders, farmers' organizations or the farmers themselves. The contracts involve providing assistance to farmers in return for the crop. A similar approach is adopted by large international processing companies, which may either place staff members in the producing area to negotiate with suppliers or employ a local agent to act on their behalf. Contract farming comes in various forms and includes term purchasing arrangements, out-grower schemes and nucleus estates.

Informal linkages and ad hoc arrangements

In many scenarios contracts are not written down but rely on verbal agreements between entrepreneurs and farmers. Informal arrangements are common in markets with less stringent quality requirements for example and when planning skills of producers and processors are limited.

4. Factors Influencing the Strength of the Link

The type and strength of linkages formed between different players depends in part on their mutual interest in forming and maintaining agreements, but also on other factors including the physical and institutional environment, and the types of products or processes involved. In general, good communications and transport promote stronger linkages between farmers and traders or processors while adequate utility services support the development of agribusinesses near to producers.

Nature of Product

The nature of the product is an important factor determining the collaboration between producers and processors. Highly perishable, labor intensive crops, which do not have an alternative market, ensure very close collaboration between farmers and agribusiness firms. This is clear from the involvement of the agro-processor in production matters such as the provision of seeds, agro-chemicals, credit, extension services, as well as providing assistance in establishing produce collection centers. Where a product is not highly perishable, sensitivity towards important aspects of the product supply and marketing may not be given the necessary importance.

Support of Farmers' Organizations

The existence of farmer's organizations such as producers' co-operatives or associations and agricultural lobby groups are beneficial to commercialization of agriculture and agribusiness development. Farmers as individuals especially in small holding systems are at the weak end of the economic exchange system. They therefore have to evolve strategies to enhance their market power. Farmer's associations can be responsible for configuring its members with market requirements including training, extension, technology acquisition, provision of commodity inputs and co-coordinating harvesting-delivery schedules.

On the other hand, agribusiness firms can deal more efficiently with farmer’s association by acquiring representation in the management structure, as well as, allowing the producers’ association to be represented in its own management structure. The agribusiness company, moreover, can further influence the efficiency of the farmers’ association by ensuring this body maintains records, has no political agenda, and is limited in size and that it contains sufficient professional management.

Role of the Initiator of the Link

Successful farm-agribusiness development depends on the role played by the initiator. In generals, linkages are initiated by either a business entity or more traditionally, by a government agency responsible for the development of a particular commodity. Where profit making for the initiating entity is essential, the initiator plays a greater role in developing farm-agribusiness linkages. Private sector enterprises have proven faster in establishing linkages with the agricultural sector than public institutions. However, there is a tradeoff for profit making entities between developing sustainable relationships and the costs associated with providing farmers with necessary incentives to produce.

Creation of Asset Specificity

Other factors that favor the creation of stronger linkages include greater product specialization by farmers and processors. The creation of mutual asset specificity reduces uncertainty and

raises the exit costs of both sets of contracting partners. Asset-specificity is high in tree crops for example due to long production cycle compared to annual crops. Capital intensive processing equipment with a long amortization period creates a high specificity and increase exit costs.

NGO Facilitation

Institutional facilitation by international NGOs has assisted mutual beneficial links. With under-funded government extension services and limited knowledge, experience and financial strength of many agribusiness companies, NGOs can play a fundamental role in establishing and maintaining farm agribusiness linkages. This involvement has a large component of providing advisory and extension services to farmers in the absence of inadequacy of public advisory services. However, NGOs should be aware of not to create unfair competition by offering subsidized, and hence long-term unsustainable incentives, such as subsidized farm-gate price, credit, inputs etc.

5. Financing Opportunities in Agribusiness

Agribusiness have a huge business opportunity and a chance to contribute to the sustainable development goals (SDGs). Financing opportunities for inclusive agribusiness are growing. The financing instruments are:

i) Public-private partnerships, a long-term contractually based mutual cooperation between public and private sector aimed at the provision of public services.

ii) Project finance, which mainly targets large-scale and long-term projects and it protects the undertaking company in case of failure.

iii) Blended finance, a mechanism that uses public and philanthropic funds to leverage private capital in order to meet the financing needs of an inclusive business.

iv) Result-based financing is used by developing country governments, or states or donor agencies, in cooperation with the private sector, to incentivize the provision of goods or services to create or expand markets, or to stimulate innovation.

v) Thematic bonds, a sustainable investment option that is beginning to attract a new generation of investors.

vi) Agricultural value-chain finance is financing provided to an actor in the chain by a financing source outside of the value chain or by another actor in the value chain.

vii) Crowdfunding, brings together multiple private investors to fund a project for a specific cause, usually start-ups with the desired impact as main reason why investors choose one project over another.

viii) Impact investment funds, curate a selection of carefully vetted businesses, which seek funding towards an impact area or around a regional focus.

Agribusiness can be used to develop the economy. But it needs proper financing as well as marketing strategies. However, no strategy will be successful unless and until it can be properly implemented. This can be feasible only when both public and private sector will give proper importance on agribusiness linking with smallholder farmers.

6. Benefits and Constraints in Farm-agribusiness Linkages

Farmers' benefits include having assured produce markets, minimizing production risks, transfer of knowledge on the latest farming technology, supply with crucial agricultural inputs, often on credit. As for farmers, processors benefit from assured raw material supplies without commitment of land and labor resources. Also they are exercise control over the production system in order to comply with set standards of relevance to accessing markets. Managed co-ordination facilitates production and marketing planning. Despite the obvious benefits a number of constraints in farm-agribusiness linkages. Constraints can be classified as internal and external.

I. Internal Constraints on Farmers and Agribusiness

Lack of Business Management Skills

Poor production planning and marketing skills, especially by small-scale processors, results in a failure to take account of inputs needed to process scheduled amounts of raw materials. Production rates are then insufficient for the amount of crop ordered from the farmer, and processors fail to collect the crop when agreed. Processors also fail to plan for equipment or power failures by ensuring an adequate level of spare parts or backup power generation. This causes production to halt and this has similar knock-on effects on raw material requirements and output marketing. Financial planning skills by agribusiness entities are especially important during the harvest season. Large amounts of working capital are needed to buy seasonal raw materials in adequate quantities, and poor planning may result in delayed or non-payment for crops. This lack of financial awareness, together with low levels of profitability in many small enterprises, also means that processors are unwilling or unable to afford extension advice to farmers, or support them through provision of agricultural inputs or credit. For a large majority of smaller companies, these constraints effectively prevent them from entering into formal contractual arrangements with farmers.

Raw Material Procurement

Difficulties in establishing and maintaining reliable and sustainable supply relationships between farmers and processors can lead to poor business planning and management. Offseason supplies are particularly difficult to maintain in rain fed farming systems. Gluts of raw farm produce during harvest time are common and with lacking storage and preprocessing facilities, continuous processing activities are difficult set up.

Socio-economic discrepancies between farmers and agribusiness create difficulties in establishing long-term, business relationships. Many processors see farmers as simply a source of raw materials and have no interest or no financial resources in supporting or developing them. Others have little respect for farmers and regard them as inferior partners in an agreement. This creates tension and leads to breakdown of agreements, with farmers feeling exploited and reneging on their commitments. Additionally, the lack of trust between farmers and the lack of organizations to work together to meet a processor’s requirements, result in insufficient volumes of crops for processors.

Quality Constraints

Farmers often have little understanding of processors’ requirements for specific crop varieties, high quality standards, specified production volumes or timeliness of delivery. Their lack of commercial skills and knowledge of the way in which commercial enterprises operate is a significant constraint on development of effective linkages. Lack of knowledge and skills also cause farmers to harvest crops when they are immature, cause damage to crops from poor post-

harvest handling, and not sort crops into different quality grades. Each of these restricts farmers' ability to meet buyers' requirements and again reduces their income.

Financial Constraints

Lack of resources for farmers ultimately arises from insufficient income from their crops, although there are multiple reasons for this. For example, delayed payments from buyers and lack of access to credit create indebtedness, and high interest charges for informal loans by rural money-lenders or middlemen continue the cycle of poverty. Farmers are unable to afford inputs that would reduce damage and maintain the quality of their crops, or afford post-harvest technologies which would enable them to store crops until prices increase out of season. The need for income as soon as possible during the harvest season and high levels of theft from fields or food stores in many countries, prompts farmers to harvest crops before full maturity and to avoid storage for later sale. Each reduces farmers' potential income and prevents them meeting their side of an agreement with processors.

II. External Constraints on Farmers and Agribusiness

Among numerous external constraints that face both farmers and agribusiness, the following have significant effects on the creation of strong linkages.

Adverse Macroeconomic Conditions

Inconsistent and not transparent business rules and regulations in general hinder business development. In countries with high taxes, a poor tax administration and high levels of corruption, any economic development is stifled. Poor monetary policies are reflected in high interest rates and devaluing exchange rates. Credits from financial institutions are difficult to obtain and loans are unaffordable in high inflation/ high interest rate environments. Devaluation leads to rising costs of imported inputs. Shrinking government expenditures on agriculture are rather the norm than the exception in most agricultural based countries.

Market Constraints

Limited purchasing power of consumers in developing countries results in low demand for processed goods. This in return limits the profitability of agribusiness. Additionally, small numbers of processing companies are insufficient to support local manufacturers or supply agents of processing equipment, packaging and ingredients, each of which acts as a brake on development of agribusiness. Trade liberalization policies have increased competition with imported raw materials and processed goods.

Lack of Institutional Support

Coherent public agricultural, business and industrial development strategies are lacking or there are problems with implementation. Budgetary pressures have led to under-funded education sector. Also educational institutions often have insufficient understanding of the needs of farmers and agribusiness, and lack both the resources and commercial awareness to implement practical programs of support. Additionally, their organizational structures may be geared to offering staff promotion based on publications in scientific journals rather than successful assistance to target beneficiaries. Government policies to support applied research and development may not be coordinated with agricultural and industrial development policies, or may even conflict with them. Extension services often have inadequately resources. Extension agents may be technically trained, but lack marketing or business skills or skills required for improving farmers' business opportunities and their organizations. In countries where extension

services and rural banking are inadequate, traders are the only effective source of agricultural inputs or short term loans, and farmers are unwilling to enter into contracts with processors, or may be prevented by traders from doing so.

Limited Availability of Inputs

High costs of raw materials in both, farming and processing, lead to a low profitability in the agricultural and business sector. Inputs necessary for adding value to primary products are often imported while local intermediary goods suppliers cannot compete on price and quality of imports.

Restricted Market Information

Public services are under-funded so that little or no published information on markets, prices, trends, key market players. Commercial market research services are rare and costly.

7. Conclusions

The vast majority of smallholders lacks education, has severely limited access to communications or physical infrastructure, may suffer from poor health and nutrition and lacks remunerative markets and access to yield-enhancing inputs. International competition from often distorted world markets is high and threatens to marginalize the majority of smallholders.

Processors in low-margin sectors with limited skills and assets face constraints to ensure on and off-seasonal raw material suppliers. Spot market transactions on an ad-hoc basis are the norm and the provision of extension services therefore out of reach. With uncertain raw material supplies of adequate quality and quantities, and with high cost of coordination, processors find production planning a crucial constraint that also leads to marketing problems. Low market demand for value-added products increases marketing constraints. Lack of product quality, reliability and commercial orientation are the most commonly criticized features of farmers. However, a number of positive developments in agribusiness can be found across the region. The horticultural and dairy sectors have recorded upward trends while incorporating smallholders. Horticultural exports also have increased over the past decade. The farming and processing sectors are undertaking actions to include previously disadvantaged farmers. Negative international price trends of traditional exports have been reverted in some cases by pursuing high quality niche markets.

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Role of Agricultural Extension in Sustainable Agribusiness Development

Dr Sharif Uddin Ahmed Rana and Ben Banerjee

Introduction: Bangladesh is an Agro-based country. It is a great delta-comprises with hundreds of rivers, plane lands and hills. The length of its coast beside Bay of Bengal is about 1700 km. Due to its geographical location Bangladesh is always disaster prone. Flood, storm, drought, tidal search etc are the part of its existence. On the other hand the country has been ruled by the different outsider resume since long. Resulted, poverty and famine were, the long-lasting feature of the livelihoods of the people of this land. Therefore, the history of introduction of modern agriculture in Bangladesh is not too old. This history is very much related with famine and poverty. After series of famine the British Government took some steps for introducing agricultural services sector. They have established Dhaka farm and Laboratory Building in the early 1900. The Chief Minister of greater Bengal Sher-e-Bangla A K Fazlul Huq established Agriculture college in Dhaka in the year 1937 for equipping our earlier generation with modern agriculture education and research.

Till the end of Pakistani resume there were not much progress in – dissemination of agricultural knowledge and technologies to the farmers-except establishment of Agricultural University in Mymensingh in the year 1961 and establishment of Directorable of Agriculture (Extension and Management) BARI and BRRI in the year's 1968, 1969 and 1970 respectively.

The real development in agriculture has been started after independence in 1971. Our great Leader and Father of the Nation Bangobondhu Sheikh Mujibur Rahman has given utmost importance in quick growth in agriculture development for the happy and prosperous livelihoods of the people of Bangladesh. Most of the agricultural research and extension organizations had been established under the visionary leadership of Banganondhu. During, his very short period of contribution the country able to established the base structure of almost all the needful organizations for the rapid growth of agriculture. Therefore, we can call him the pioneer of establishing the modern integrated Agricultural system in Bangladesh.

Agricultural Extension in the Agribusiness:

We all know that the significant characteristics of our agriculture was termed as subsistence agriculture. Due to manifold efforts now it has been transformed in to commercial agriculture i.e. agribusiness. About more than 200 crops are being growing in Bangladesh. We have also plenty of fishes and other animal resources. In recent decades Bangladesh has achieved a lot in the many areas of agricultural production. Our great leader, Honorable Prime Minister Sheikh Hasina the daughter of the Father of the Nation Bangobondhu Mujibur Rahman has given outstanding support for the development of agriculture. Agricultural Education, Research, Extension, input and

machinery supply systems are working for enhancing agricultural production and productivity. As a result we have achieved a lot but we have to go far. We have declared our SDG targets. In order to achieve those targets – specially doubling production and productivity as ell as availability and accessibility of safe and nutritious food for all. Besides we have challenges lies with climate change risks, loosing of productive land, population growth, adaptation with changing food system, value addition of agricultural Products and marketing, coup up with gradual shortage of labour forces through introducing adequate mechanization etc.

We have to overcome all these challenges through strengthening our agricultural education, research, extension and marketing systems. In order to do that we have to find out the laps and gaps in those systems and ways out to overcome the existing laps and gaps.

What to do for the farther improvement:

As subsistence agriculture is transforming is to agribusiness-therefore we have to find out and implement the new extension roles effectively to expedite the transformation process. We have to understand and met the demand of the time and its reality.

Therefore we need to give emphasis on increasing agricultural productivity, commercialization of agriculture, climate risk management, increase production of nutritious and safe food, reduction of post harvest loss through proper post harvest management, Initial processing and marketing of agricultural commodities, increase exports, using advance technology, farm mechanization, water saving irrigation system, integrated crop production and farm management system, implementation of good agricultural practices and organic agricultural technology, increased participation of women in agriculture and use of ICT in agriculture. Considering these Priority areas most suitable agricultural extension system and approaches will be developed and implemented.

Present Status:

Out of various public agricultural extension agencies only Department of Agricultural Extension has been following the guiding principals of Agricultural Extension Policy. Department of Livestock, Services and Department of Fisheries has huge limitation due to weak and less effective organizational structure and continuous shortage of skilled manpower.

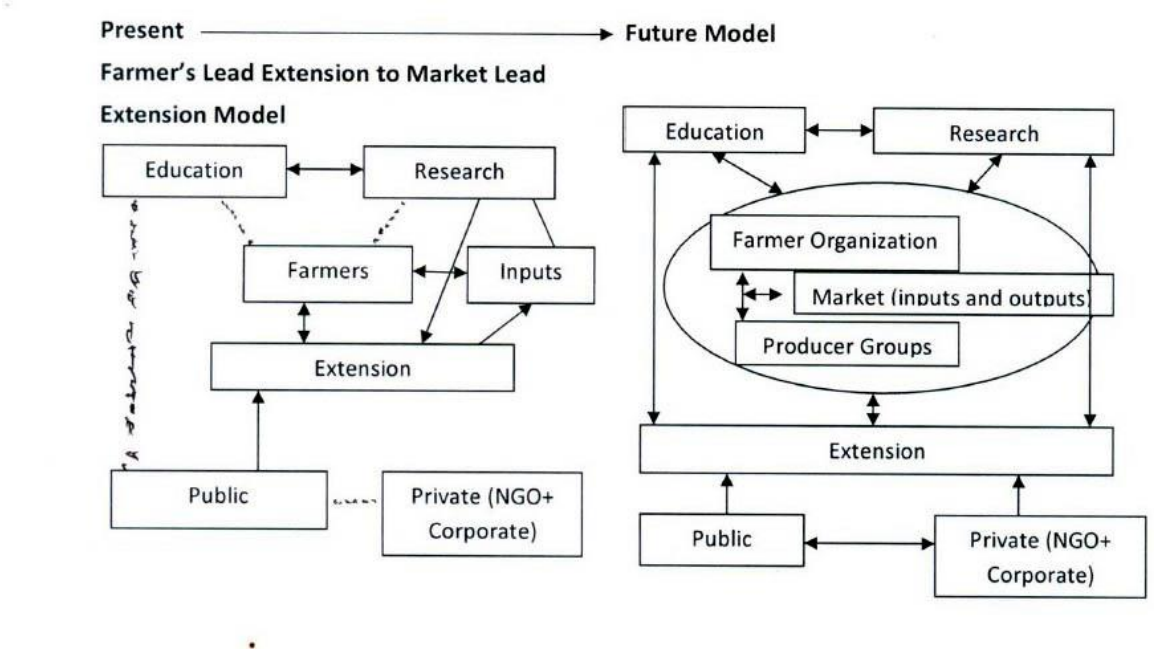
Still our agricultural extension system is focused on improvement of the livelihoods of farming community. In doing so project based group approaches (Farmer Field School -

FFS, IPM club, small farmer Group SFG, Common Interest Group-CIG, Farmers Organization - FO etc. These type of groups having diversified goals and objectives are not being sustained due to many reasons. On the other hand interruption of approaches in the farming communities has been creating wastage of resources.

Shifting Needed:

In this circumstances shifting needed from project based group approaches to stable and permanent farmers organization at the producers level along with strong market linkages. It will be the entry point of extension services.

Beside this farmer centered approaches must be shifted to product/produced centered approaches – due to the demand of the mechanized and commercialized agriculture.



- We do not have structured coordination in between education, research and extension organizations. Which is very needed for sharing and updating the growing issues and the way to solve the issues in the development of agriculture.
- Still our farming system is almost integrated by nature with crop, livestock and fisheries. But we do not have formed and regular coordination. Within these disciplines, we have to adequate and effective coordination at central i.e Ministry and Departments level, district level and upazila level.
- There are hugest gaps in organization capacities in terms of organization and skilled manpower in educational research and extension organization by introducing a regular human resources recruitment and development plan.

- We know that the private sector is growing very first in agricultural fields in Bangladesh. They have their own research and development initiatives. But here we do not have structured coordination system with private sector. Though our latest Agriculture policy and extension policy have given proper emphasis on working with private sector by developing effective public private partnership.
- Many national and international NGOs are also working here in the field of enhancing better livelihoods of rural communities through improved agricultural practices. Unfortunately we have also coordination gaps. We have to overcome it through development of needful coordination with NGOs.
- Linkage within agro-processing industries, farmers, researchers and extensionits are not existing significantly. But, for value addition and diversification of processed product this linkage could play effective role which also can contribute to escape farmers from unfair price of their products.
- Role of women are being increasing in agriculture. Women farmers need to equip with production and nutrition knowledge and skill as they can play outstanding role in establishing improved agriculture in Bangladesh.
- Use of ICT in agriculture is another area we have to give emphasis for quick dissemination of agricultural information and technologies. Young and educated farmers will be interested to use the ICT for improvement of agricultural practices.
- Ones educated youth people were not interested in agricultural farming. But, now due to commercialization and mechanization in agriculture the mind set of young educated people is being changed. Gradually they are coming and getting interest in agro-farming. Therefore now is the time to encourage them by providing all sorts of incentives.

Strengths and Weaknesses of National Agricultural Research Systems in Enhancing Agribusiness of Bangladesh*

Dr Sharif Uddin Ahmed Rana, Adrian David Cheok and Humaira Tanzila

Abstract

Bangladesh has a well-organized National Agricultural Research System under the umbrella of the apex body-Bangladesh Agricultural Research Council (BARC). There are twelve separate agricultural research institutes to conduct research on crops, livestock, fisheries and forestry. A large number of technologies have been developed by those research institutes, and some of them have already been transferred and adopted by the farmers. Ultimate results of those technologies are visible in the farmers' fields; and the production of crops, livestock, fisheries and forestry have been increased in many folds. In one hand, Bangladesh has a number of reputed agricultural research institutes; in the other hand, those organizations have some weaknesses like lack of advanced research facilities, shortage of qualified scientific manpower, inappropriate incentives for the working scientists, limited scope of short and long term foreign training for the scientists, and poor international funding for agricultural research. There is also a lack of communication between agribusinesses and agricultural research institutes. The prospects of agribusiness for this country is yet to be adequately understood and studied. Agribusiness consists of the following three sub-sectors: agricultural input sector; production sector; and processing-manufacturing-marketing sector. These sub-sectors are highly interrelated where the success of each part depends heavily on the proper functioning of the other parts. Research Institutes develop technologies like- new HYV seeds, fertilizers, irrigation systems, insect and disease control measures. These Institues also develop machineries for soil cultivation, intercultural operations, irrigation, harvesting, threshing, cleaning, drying, packaging and storing. Agribusinesses supply the inputs like fertilizers, pesticides, seeds & saplings, all sorts of agri-machineries and also produce agricultural final products like grains, vegetables, fruits, fibers, fishes, eggs, meats, woods. The transportion of all these inputs and outputs is part and parcel of agribusiness.. There is a need for greater collaboration between researchers and actors of the agribusiness system to address emerging issues.

Keywords: NARS, Agribusiness, Strength, Weakness, Agri-products.

I. Introduction

Agriculture remained the driving force behind the economic growth of Bangladesh during the 20th century and would continue to remain so for years in the 21st century. About 70% of the total population of Bangladesh live in the rural areas and directly or indirectly engaged in a wide range of agricultural activities. The agriculture sector, including crops, livestock, fisheries and forest sub-sectors contributes a major share to the Gross Domestic Products (GDP), considering the contribution from rural non-farm sector driven by agriculture, the share of agriculture in total GDP is still quite high. In one hand, agriculture being the largest income and employment generating sector, its contribution towards alleviating poverty is significant. On the other hand, its role in meeting the challenge of achieving self-sufficiency in food production and fostering sustainable agricultural development is considered as the key driver for the of pro-growth strategy development is remarkable. Bangladesh is one of the most densely populated countries of the world with more than 160 million people in 147,570 square kilometer having the density of 1100 people per sq.km.

Around 70% of the people in Bangladesh are directly or indirectly employed in agricultural sector. The net cultivable area is 8.52 million hectares out of 14.76 million hectares which reflects 57.72% of the total country's area. The contribution of agricultural sector in GDP is 14.77% (2016), employs 47% of the total labor forces, cropping intensity over 192% approaching to 200%, average farm size is about 0.68 acre and more than 46 economic crops are grown in the country(BBS,2017). The farmers are engaged in crops and as well as fisheries and livestock production with a view to utilize available natural resources and improving their livelihood. Bangladesh has made a considerable achievement in Agriculture Sector especially in food grain production. Over the last four decades, cereal production has increased from about 10 million tons in 1970s to more than 39.68 million tons in 2016-17 i.e. increased about four times, although arable land decreased from 9.8 million hectares to 8.27 million hectares (FAO, 2017). Bangladesh is self- sufficient in rice and potato production but other crops like pulses, oilseeds, spices, fruits, vegetables and other cereal crops are not sufficient as per need. Agricultural research institutes of Bangladesh have been playing significant role in developing high yielding varieties and improved management practices for different crops grown in Bangladesh.

Agribusiness is one of the most challenging businesses in the world. Bangladesh depends heavily on agriculture, but the prospects and potentials for agribusiness for this country is yet to be adequately understood, studied, and its enormous potential explored. This sector is the best as an emerging stage of development. Bangladesh cannot sustain long-run macro-economic stabilization and economic progress without having a strong agricultural sector accompanied by a dynamic agribusiness sub-sector (Ali and Islam, 2014). From a practical perspective, agribusiness may be defined as various value-adding and synergy-enhancing activities based on agro-based products along with its related upstream and downstream activities ranging from improved seed development, plowing,

raising& harvesting various agricultural crops. The products processing, marketing, distribution, storage, transportation, new product development, export promotion, and many other value adding activities are under agribusiness. From this perspective, it would be obvious that agribusiness and agricultural trade may include myriads of activities mentioned above done on a commercial basis and utilizing more modern and scientific production methods and technologies.The term 'agribusiness' is important to visualize based on the following three sub-sectors: the agricultural input sector, the production sector, and the processing-manufacturing-distribution sectors, which are highly interrelated as part of a system in which the success of each part depends heavily on the proper functioning of the other two(Beierlein and Woolverton,1991), Further, it also argue that the agricultural markets are joined together among various components of the food industry, the supply sector, the farm sector, the food marketing system, among others, within the national economy(Kohls andUhl,2002)

II. National Agricultural Research Systems in Bangladesh

Agricultural research in Bangladesh has a long history. Farmers have been searching for better ways of growing their crops, livestock, fisheries and forestry since organized cultivation came into existence. National Agricultural Research System of Bangladesh reached the end of the century. It is composed of over 2000 Scientists working at different research organizations. Several educational institutions are also conducting research in some fields of agricultural science. The Bangladesh Agricultural Research Council (BARC) is the apex body of the national agricultural research system. It has the responsibility to strengthen the national agricultural research capability through planning and integration of resources. The growth and development of the national agricultural research system which had taken place since independence had been planned to meet the special needs of this country. After independence, the Father of the Nation Bangobondhu Sheikh Mujibur Rahman in 1973 re-organized Agricultural research system of Bangladesh, and established Bangladesh Agricultural Research Council with the aim of coordinating systematic agricultural research in the country. Under the provision of BARC Act 1996, NARS has been reorganized with BARC as the apex body with twelve agricultural research Institutes (BARI, BRRI, BJRI, BINA, BSRI, BFRI (Fisheries), BFRI (Forestry), BTRI, SRDI, BLRI, BSRTI and CDB) are the constituent units. The agricultural universities, NGOs and private sectors, though not integrated but linked with NARC in terms of research collaboration.

Crop specific research institutions served the major commodities of rice (BRRI), jute (BJRI), sugar (BSRI), and tea (BTRI). Each of the primary institution under the Bangladesh Agricultural Research System had a specific mandate. Each institution is involved with a wide range of applied and adaptive research activities. Many of the activities are multi-disciplinary and inter-institutional in nature. The Bangladesh Agricultural Research Institute (BARI) is the largest and most diversified. It has primary responsibility for research in oilseeds, pulses, tuber crops, spices, wide range of vegetables, fruits and flowers. Multidisciplinary researches are conducted for different crops. There are a number of crop research centres within BARI i.e. Horticulture Research Centre, Tuber Crops Research Centre, Spices Research Centre, Wheat ResearchCentre, Oilseeds Research Centre, and Pulses Research Centre. Very recently, in 2018 to emphasis more research on wheat and maize, a separate institute i.e.Bangladesh Wheat

and Maize Research Institute (BWMRI) have been established with the head quarter in Noshipur, Dinajpur by the present government. Among the twelve research organizations including BARC, six are autonomous bodies under the Ministry of Agriculture and the remainders are under other Ministries; and two institutes BFRI (Forest) and SRDI are government departments.

A list of National Agricultural Research Organizations of Bangladesh is given below:

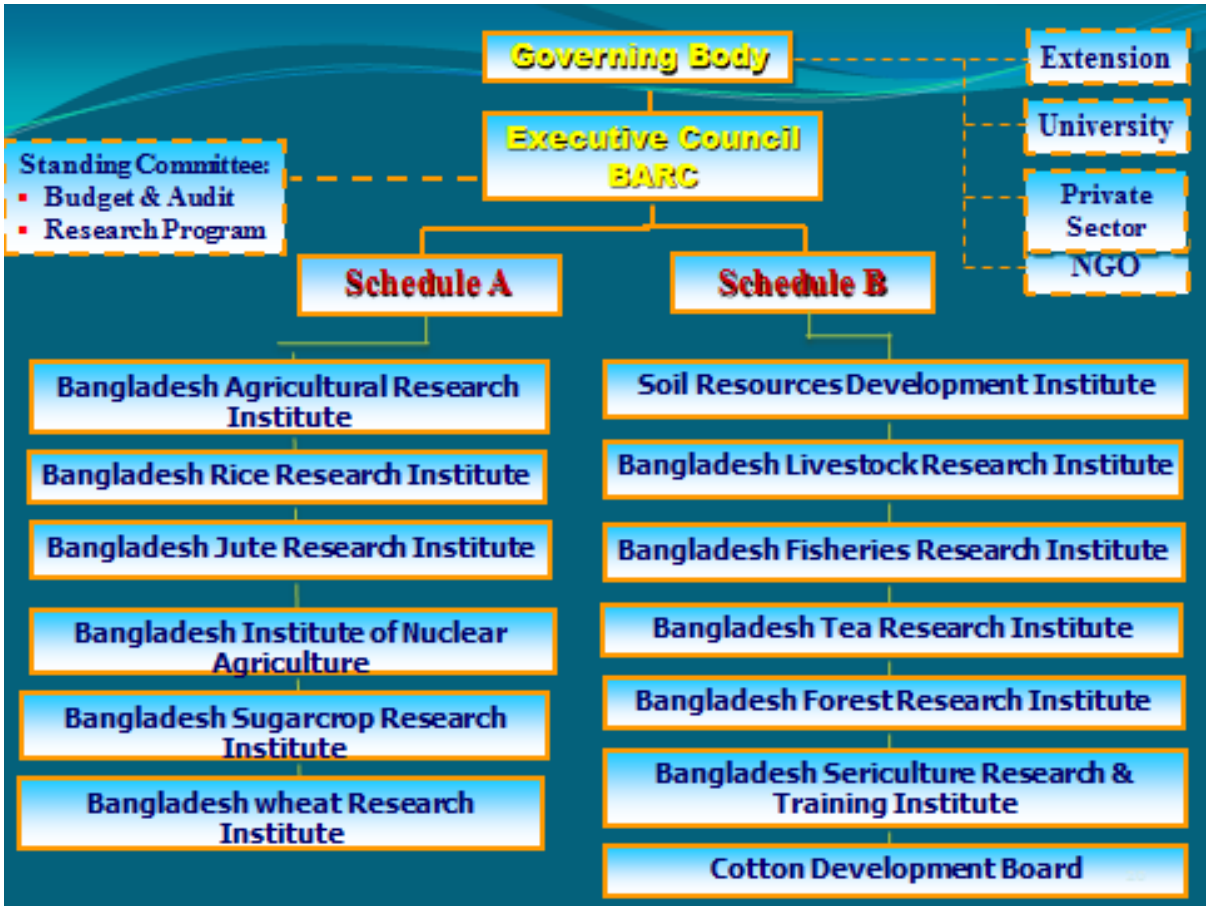


Fig.1. National Agricultural Research System (NARS) of Bangladesh

III. Research Achievements of NARS Institutes

Increase of food production during the last four decades has been phenomenal. This was due to the large number of cutting-edge technologies developed by theagricultural research institutes of Bangladesh. A brief description of the developed technologies is highlighted inthe following sections:

01. Bangladesh Agricultural Research Council (BARC)

- More than 50 promising technologies e.g. development of aromatic and saline tolerant rice varieties, summer tomato development and dissemination, and irrigation water management in hills etc. are developed under SPGR sub-projects etc.

- ❑ Agricultural Research Management Information Systems (ARMIS) project was implemented by BARC for management of information on agricultural research conducted by different NARS and other organizations.
- ❑ Preparation of Research Priority and Vision Document-2030. This document highlights the priority areas of agricultural research and development.
- ❑ Human Research Development Plan 2009 – 2025, has been prepared for skill development of NARS scientists.
- ❑ Considering the crop suitability and efficient use of natural resources 'Crop Zoning' map for 17 crops has been developed.

02. Bangladesh Agricultural Research Institute (BARI)

- **BARI Works on 206 Crops**
- BARI Developed Total 1050 Technologies
- Crop Variety: 545
- **Other/ Non-Crop Technology**: 505

Table 1. Variety Released so far from BARI

Sl. No.	Name of Crops	Varieties released
01.	Wheat, Maize, Barley etc.	78
02.	Oilseeds(Mustard, Sesame, G.nut, Soybean, inseed, Niger, sunflower)	46
03.	Pulses (lentil, Chickpea, Mungbean, Blackgram, Pigeon pea etc.)	42
04.	Tuber Crops(Potato, St. potato, Seed tubers, different types of aroids)	109
05.	Vegetables (Brinjal, Tomato, Types of gourds and types of leafy veg.).	120
06.	Fruits (Mango, Jack fruit, Banana, litchi, Amra, Papaya, Minor fruits	85
07	Flowers (Tube rose. Zerbera, gladiolus, dahlia, orchids, etc	19
08.	Spices (Onion, Garlic, Dhonia, Chilly, Turmeric, Zinger,etc	39
09.	Other crops (Narcotic, Fibre)	7
10	Total	545

03. Bangladesh Rice Research Institute (BRRI)

- ❑ Developed 89 rice varieties (HYV). BRRI dhan-28, 29 are mega varieties.
- ❑ These varieties are of different traits, (Short duration; aromatic; salt, pest & disease, drought & submergence tolerant)
- ❑ Maintains germplasm of 7000 land races in genebank
- ❑ 19 BRRI varieties are grown in 14 different countries
- ❑ Total rice Production: 35 Million (BBS: 2017)

04. Bangladesh Institute Nuclear Agriculture (BINA)

- Eightyseven (87) varieties of different crops (rice: 18) developed.
- Varieties of pulses, oilseeds and production technologies developed using nuclear technique

05. Bangladesh Sugarcrops Research Institute (BSRI)

- Developed 44 varieties of sugarcane (pest & disease, water logging, short duration, sugar content)
- Developed 02 varieties of sugarbeet

06. Bangladesh Jute Research Institute (BJRI)

- Developed 44 varieties of quality jute and allied crop and other technology (40 Nos.)
- Jute Genome study
- Diversified environment friendly Jute Products

07. Soil Resources Development Institute (SRDI)

- Location specific fertilizer Recommendation
- Soil health service
- Soil & Fertilizer analytical service
- Soil Survey

08. Cotton Development Board (CDB)

- Developed 15 varieties of cotton including 01 hybrid
- Rice-Cotton intercropping in the hilly areas.
- Cotton production in saline soil

09. Bangladesh Tea Research Institute (BTRI)

*18 improved Tea clone released

- 05 hybrid tea seed of bi-clonal and polyclonal stocks developed
- Pruning cycle for optimum crop production determined
- Developed appropriate pest-management technique

08. Bangladesh Sericulture Research and Training Institute (BSTRI)

- Development of 9 high yielding mulberry varieties
- Development of 28 high yielding silkworm races
- Innovated solar dryer for cocoon drying

09. Bangladesh Forest Research Institute (BFRI)

- Development of bamboo propagation technique through branch cutting.
- Preservative treatment of wood, bamboo and other thatching materials for increasing durability.
- Increment of rubber latex production by optimum fertilizer dose.
- Agar production in agar tree by artificial inoculation and wounding method.

10. Bangladesh Fisheries Research Institute (BFRI)

- Breeding & Hatchery Management of Carps
- Improved seed production & nursery management
- Breeding & seed production of important fish species, GIFT & Monosextalapia, Golda, gulsha, catfish etc.
- Carp polyculture, Cage & Pen Culture

11. Bangladesh Livestock Research Institute (BLRI)

- Total 65 technologies on improved varieties and Feed for Animal, layer etc. have been developed.

IV. Weaknesses of National Agricultural Research Systems

Some problems of National Agricultural Research Systems are given bellow:

1. Until today Scientific establishments (i.e Advanced research laboratory.) with the requisite physical infrastructures and facilities are very poor.The investment trend in agricultural research in the recent past has been rather erratic. Thus the situation reveals the lack of realistic, sustainable and systematic supportive investments in the whole agricultural research sub-sector of the country.
2. Thequalified scientific manpower in the NARS institutes is very limited. The scientists having with Ph.D degree is around 35%.
3. There is no communication at all between NARS institutes and agribusiness organizations.
4. The quality of the research output have been far below what could be expected in terms of potential capabilities.
5. Inappropriate incentive structure for the working scientists. An acceptable promotion system for the NARS scientists is not yet established. Qualified and well trained scientists going to retirement like the other employees. Scientists retirement age needs be extended. Brain drain should be stopped.

6. Now- a- days, the scope of short and long term foreigntraining for the scientists is very limited.
7 .Weak collaboration between International agencies and NARS

7. International funding for agricultural research is very low than the past.
8. Relationship of NARS institutes and extension agencies (public & private) is also weak.

V. Role of Agribusiness in Bangladesh

Since independence in 1971, the country has been striving to improve economic performance and reduce poverty and to become a middle-income country. In this striving, the agricultural sector in general and the agribusiness in particular has the potential to perform a number of critical roles in transforming the country in the desired direction. The sector can provide food for the rising population and the rising urban sector, generating income and employment opportunities for rural population, supplying labor as well as materials for the rising manufacturing and service sectors, providing a market for the country's growing industrial sector, and generating investable surpluses and foreign exchange earnings that could be utilized for developing the country-side as well as the entire economy. On the other hand, the industrial sector of the country can provide critical supports to the agricultural sector in the form of supplying agricultural implements, various other critical inputs (such as fertilizers), improved technology, additional agribusiness-related investments, and providing ready markets for rising agricultural and agribusiness output.

Despite significant structural transformation, the policy frame works would continue toview agriculture as an active and co-equal partner with industry and other sectors during the post-MDGs period (Mujeri, 2014). This is mainly due to two considerations: first, agriculture produces goods that directly satisfy basic human needs, and second, agriculture production combines human effort with natural resources. As such agricultural growth must match withthe population growth. Moreover, the later generation dual economy models make it apparent that functions that agriculture and Industry sectors must perform are totally interdependent. Agriculture sector must release resources for industry which in turn must have the absorbing capacity. Growth can occur only if release-cum-absorption of laboratory.

If properly encouraged, promoted, and managed, agribusiness may have the potential to play a strong role in providing rural income, employment, food security, poverty alleviation, and improved external balance position, and thereby contribute to overall industrial and economic development of the country.As Bangladesh suffers from serious employment problems due to over-population and given that food availability is becoming scarcer in the country over time as population increases, income grows, and urbanization takes place, the potentials and prospects for agribusiness in the country should be viewed and explored as critical for the development of the country. As such, strategic management of agricultural business and trade is extremely important so that core competencies can be created and proper supply chain management along with vertical and horizontal integration could be established in the process of promoting and developing agribusiness in the country.

VI. Agricultural Research and Agribusiness

High yielding varieties of different crops are developed by theAgricultural Research Institutes but seeds are multiplied and traded by the private seed companies; Farmers collect seeds from seed stores or seed dealers. So seed business is done by the private business men. In the similar way, most of the sapling or seedlings of fruits or other trees are also multiplied and marketed by private nurseries. Nursery business is alsoan established business in all over Bangladesh. Only a certain portion of seeds and saplings of few selected crops/fruits are multiplied and supplied by BADC. So there should begood relationship and communication between researchers and seed business men.Fertilizer recommendation for different crops is done by agricultural researchers, but whole fertilizers business is done by private business men.

Methods of irrigation and different irrigation implement are developed by researcher.But these irrigation implement are traded by private business men. Other implement forcultivation of soil, intercultural operations, harvesting, threshing, cleaning and processing, packaging, are also developed by the agricultural researchers but the entire implement are also traded by private business men. All agricultural inputs, primary products, processed products and machineries are transported by the business men.The input supply and farm products markets are often referred to as agribusiness. Agribusiness is a generic term for the various businesses involved in food production, including farming and contract farming, seed supply, agro-chemicals, farm machinery, processing, marketing, wholesale and retail distribution (Wikepedia 2012)

So a large number of agribusinessis did by the private business men. But the relationship between researchers and agribusiness men is very poor. The relationship and communication should be closer and stronger.One can safely argue that proper development and better management of the agribusiness in the country can also improve the country's scarce natural resource utilization and help to achieve better ecological balance and environmental management. Agricultural researchers and agribusiness men come closerby visiting each other working place, inviting agribusiness men in the seminar/symposium, field day, training programme and in technology demonstration programme.

VII. Conclusion

Agricultural research institutes have been playing significant role for the generation of new technologies for the development of crops, livestock, fishery and forestry sectors. So steps should be taken immediately to remove the prevailing weaknesses of the national agricultural research systems. Encouragement, promotion, and management of agribusiness may have the potential to play a strong role in increasing rural income, employment, food security, poverty alleviation, and thereby can contribute to overall agricultural, industrial and economic development of the country. Close relationship needs to be developed between agri-researchers and agribusiness men.

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Role of mass media in agribusiness development in Bangladesh

Dr Sharif Uddin Ahmed Rana, Rob Ederle and Nazmul Hossain

(Abstract.

Agriculture of Bangladesh is changing rapidly, from subsistence agriculture it is changing as commercial agriculture. Some days ago the country suffered a deficit food production, now the new challenge has explored with surplus production. With this change farming practice, farming behavior is also changing, agriculture farming has transformed as agribusiness.

Now Farmers do cultivation for commercial purpose. Now they are using the best seeds, using agricultural equipment. They have reduced imposing physical labor and started usage of machineries.

Mass media has played an important role in agriculture production. They informed people about new variety, new technology and profitability. Print and electronic media are encouraging people through their writing and program.

Oldest Farm Magazine Krishi Kotha by AIS is still working with the idea. Bangladesh Television and Bangladesh Betar are also broadcasting several agriculture programs.

BTV is broadcasting agriculture program since 1978. Mati O Manush, a BTV program on agriculture, is playing a vital role in agriculture knowledge dissemination and agribusiness development.

Now the country is facing several challenges in agri-business. Mass media can act positively to face the situation.)

Introduction

The Agriculture system in Bangladesh is changing rapidly from subsistence agriculture to commercial agriculture. Few years back, the country suffered major deficit in food production, but the new system has helped to surplus the production. The changes in today's farming system, has transformed cultivation as an agri-business.

In this headline we should discuss two issues

1. Agribusiness and
2. Mass media

We know **Agribusiness** is the business of agricultural production. It includes agrichemicals, breeding, crop production distribution, processing, machinery, seed supply as well as marketing and retail sales. All agents, of the food and fiber value chain and those institutions that influence it are part of the agribusiness system.

Mass media means technology that is intended to reach a mass audience. It is the primary means of communication used to reach the vast majority of the general public. The most common platforms for mass media are newspapers, magazines, radio, television, and the Internet. The general public typically relies on the mass media to provide information regarding political issues, social issues, entertainment, and news in pop culture.

Transforming agriculture: Subsistence to commercial

In recent years, agriculture is getting more attention from different people. Even some decades ago in Bangladesh agriculture was exclusively for subsistence. Farmers actually produced crops for their family consumption. Cash crop was jute, cotton which they produced and sold to manage their cash expenditure. Cultivation of vegetables in the home yard, fish in the pond was not done for commercial purpose. But sometimes the surplus of these items were sold or distributed among the relatives as gift.

Before liberation, agriculture was based on traditional technology. Application of advance method and technology was very limited.

Just after the liberation, Major changed was happened in the agricultural production systems. Through research new technologies and breed or variety were innovated. To ensure food security government has taken too many initiatives to produce more food and agriculture product in the country.

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Many giant investors started investing in agriculture. Through this gateway agriculture entered into the modern technology era from the traditional era.

Changing farming behavior

The agriculture has altered from the household maintenance to commercial purpose. The farmers today, chose to do cultivation for business purpose and harvesting the best seeds to gain advantage. The farmers are also using improved agricultural equipment to faster the production. They have reduced to enforce the physical labor and started to use machineries.

Investment has been increased from fishery to poultry. New technology has been used. Especially in poultry, huge capital has invested from plot to plate. Private sector is pioneer in this sector.

Food processing industry has been manifested; especially post production activities regarding crop cultivation have increased. Employment has been accelerated. Many young and woman entrepreneurs have started their business focusing agriculture; Intensity of cultivation is getting high. Entrepreneurs are trying to accelerate productivity by ensuring optimum utilization of land.

Export of agricultural products has been increased. Fish, vegetables, fruits etc. are exporting to abroad on a regular basis.

These changes are contentiously helping agriculture to be more business focused.

Contribution of mass media

Mass media has played an important role in agriculture production. They informed people about varieties of new technology and profitability. *Krishi Kotha* by AIS, an oldest farm magazine is still working with the idea. The Krishi *Katha* is promoting technologies and implementing government policies to ensuring food and nutrition security.

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1. To Promote **use of good seed** that create a great demand of quality seed and seed industry are getting benefit through this campaign.
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In BVT success stories were mostly telecasted which eventually encouraged new entrepreneurs. During eighties to nineties huge number of farms were established which were mostly encouraged directly and indirectly by “Mati O Manush” program.

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After 2000, private TV channels become interested to make programs focusing on agriculture. Before 2000 very few channels show their interest to make programs on agriculture. Among them ATN is one of them.

Now channel I, Bangla Vision, Gazi TV, Dipto TV are telecasting programs on agriculture. News channels are telecasting news on agriculture regularly. Newspapers are also reporting on agriculture more and more. They are also sharing success stories of farmers and agro entrepreneurs.

Mass media of Bangladesh is now very much effective and efficient for expressing news on agriculture. They are now more conscious about sharing success and limitations of agriculture.

Lot of Magazine also playing a vital role in agribusiness development. Daily newspapers, online magazine, farm magazine, social media also very active in agriculture production and agribusiness development. Facebook pages, Mobile apps are also doing well to promote agriculture technology,

Challange now a days

Though we are considering agriculture as business but information regarding this sector is still limited. Information is not available for agricultural product's market, supply and demand. That's why still our farmers sometimes can't understand which crops to produce how much to produce. These make them face the danger of affluent supply in the market. Even for this they cannot even enjoy the opportunities of gaps existed in the concerned market. Even unfortunately no attempt is noticed for surplus production.

There is no attempt from the government to control and direct the market. For the sake of open market, market is handed over to the syndicate as a result farmers are eventually becoming failures. Still our farmers are not able to understand the market for their products. They are surprisingly thrown to swim in the river though they have no ABC on swimming. Factors who are supposed to be in the backward linkage in agricultural products business they are now doing business in the market. But farmers are getting very little or no profit, however, only creative system can recover the problem.

Mass media can contribute a lot here. They should provide information to the farmers regarding market, supply demand etc. At the same time, they can provide updates on weather, disaster management, etc. related information also.

As a concerned party with agriculture, mass media workers should be given partnership; again, media workers can establish this partnership.

In the case of agriculture, business media should not only report the incosistency of this sector but also report on the solution of related problems. As a result, a constructive mutually respectful and partnership based relation will be developed. It's a vital for a sustainable agriculture buisniess.

[Rezaul Karim Siddique

Mr. Rezaul Karim Siddique is has more than 34 years of experience in conducting agricultural development programs. Mr. Siddique is the anchor of "Mati-O-Manus" the flagship agricultural program of BTV since 1983. He also, anchors a live show "Shaymol Bangla" on agricultural issues on Bangla Vision.

Mr. Siddique has extensive experience working at the grassroots with donor organizations like USAID, IFDC, Swisscontact Katalyst, and FAO. He also has in depth experience on idea marketing, designing, planning, organizing, script writing, media campaign and presenting agricultural programs successfully.]

Role of mass media in agribusiness development in Bangladesh

Rezaul Karim Siddique
Anchor, Mati o Manush, Professor, Department of Management, Savar Govt College, Savar

(Abstract.
Agriculture of Bangladesh is changing rapidly, from subsistence agriculture it is changing as commercial agriculture. Some days ago the country suffered a deficit food production, now the new challenge has explored with surplus production. With this change farming practice, farming behavior is also changing, agriculture farming has transformed as agribusiness.
Now Farmers do cultivation for commercial purpose. Now they are using the best seeds, using agricultural equipment. They have reduced imposing physical labor and started usage of machineries.
Mass media has played an important role in agriculture production. They informed people about new variety, new technology and profitability. Print and electronic media are encouraging people through their writing and program.
Oldest Farm Magazine Krishi Kotha by AIS is still working with the idea. Bangladesh Television and Bangladesh Betar are also broadcasting several agriculture programs.
BTV is broadcasting agriculture program since 1978. Mati O Manush, a BTV program on agriculture, is playing a vital role in agriculture knowledge dissemination and agribusiness development.
Now the country is facing several challenges in agri-business. Mass media can act positively to face the situation.)

Introduction

The Agriculture system in Bangladesh is changing rapidly from subsistence agriculture to commercial agriculture. Few years back, the country suffered major deficit in food production, but the new system has helped to surplus the production. The changes in today's farming system, has transformed cultivation as an agri-business.

In this headline we should discuss two issues

3. Agribusiness and
4. Mass media

We know **Agribusiness** is the business of agricultural production. It includes agrichemicals, breeding, crop production distribution, processing, machinery, seed supply as well as marketing and retail sales. All agents, of the food and fiber value chain and those institutions that influence it are part of the agribusiness system.

Mass media means technology that is intended to reach a mass audience. It is the primary means of communication used to reach the vast majority of the general public. The most common platforms for mass media are newspapers, magazines, radio, television, and the Internet. The general public typically relies on the mass media to provide information regarding political issues, social issues, entertainment, and news in pop culture.

Transforming agriculture: Subsistence to commercial

In recent years, agriculture is getting more attention from different people. Even some decades ago in Bangladesh agriculture was exclusively for subsistence. Farmers actually produced crops for their family consumption. Cash crop was jute, cotton which they produced and sold to manage their cash expenditure. Cultivation of vegetables in the home yard, fish in the pond was not done for commercial purpose. But sometimes the surplus of these items were sold or distributed among the relatives as gift.

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Technical Session V: The Role of Private Sector in Agribusiness Development

Dr Sharif Uddin Ahmed Rana and Prof Adrian David Cheok

Abstract: The role of the private sector in agribusiness development has never been more important. Governments have long-played the leading role in ensuring that populations are provided with enough food in terms of production and distribution. Now that consumers are more populous and discerning than ever before, private enterprise has been able to capture advantage by manufacturing and offering increasingly differentiated, accredited products (and services). The outcome is that private enterprise now holds vast quantities of data that reflect the nature of agri-food supply chains in a better fashion than aging government-supported databases. This paper argues for a paradigm shift in the collaboration of private enterprise and supply chain researchers so that collaboration between the two facilities real-world research that has a high-impact on reducing supply chain costs, improving supply chain efficiency and ensuring that more people have access to the unprecedented quantity of safe, nutritious food that is being produced.

The problem: World War II marked a significant change in the Western world's determination to provide its populations with a secure source of food. Many government policy interventions were put in place to ensure that there was sufficient motivation to ensure that post-war veterans went to the land to produce food rather than stay in cities. In Europe and North America, governments introduced farm subsidies to incentivise food production. The Australian government was less generous but nonetheless still implemented strategies to ensure food production was as seamless, efficient and co-operative as possible. This came in the form of government statutory authorities that gave monopoly and monopsony power to high-cost supply chain members like the railways, warehousing facilities, port facilities and international marketing bodies. In short, food production was made as easy and attractive as possible.

While the equal distribution of food to diverse populations remains a societal problem, global food production has never been so abundant. Advances in agricultural and food technologies are increasing yields and outputs more quickly than ever before; genetics, digital agriculture, farm machinery, agro-chemicals, agronomy and human capital are at their highest. With the variety and quality of food on offer, consumer preferences have also changed. The global demand for meat-based protein is higher than ever before and consumers are demanding food that this not only abundant but safe and nutritious as well. Against the backdrop of efficient food production facilitated by governments, there has been a quiet decoupling of food production from being supported by governments to being supported by the private sector. This has taken two forms: 1) the concentration of power of big agribusiness and 2) the emergence of mega farms that are providing vast quantities of food to global populations.

Mooney (2017, p. 13) reports on the issue of mergers, consolidation and concentration of power of big agribusiness and cites "the $130 billion merger between US agro-chemical giants Dow and DuPont, Bayer's $66 billion buyout of Monsanto, ChemChina's acquisition of Syngenta for $44 billion and its planned merger with Sinochem in 2018" as examples of increased concentration in global agribusiness. "Power" as a construct in human relationships (French and Raven, 1959) and organisational relationships (Nyaga et al., 2013; Jain et al., 2014) is well-understood but Mooney's (2017) thesis is that the rush to dominate and control markets through strategies of vertical integration has led to an unsustainable industry structure in which is inaccessible to other micro-players in the food system and insufficiently agile to drive the types of innovation required by food production communities. It is also suggested that ownership of and access to vast quantities of data is a motivation for this activity. Advances in information technology are facilitating the linkage of disparate data sets that are brought about by vertical integration. Big agribusinesses that value-add to customer

relationships via the provision of yield monitors, weed identification apps or livestock traceability systems are under speculation of data ownership. Are the data owned by the technology providers or the customers (farmers) who use the technology for farm business improvement? Ownership of this data could be extremely lucrative for well-connected agribusinesses. In fact, White, Carter and Kingwell (2018) discuss how Australian grain supply chain costs and competitive advantage can be improved with greater transparency throughout the system. The way to achieve this transparency is through the sharing of data.

Mergers, consolidation and concentration of power of big agribusiness has occurred relatively recently. Another business model of interest to those observing the nature of food production systems is the emergence of "mega farms", sometimes known as corporate farms or agro-holdings. Hermans et al. (2017) argues that these types of food production units have their foundations in ancient Roman agricultural and that modern-day mega farms emerged in the 1960s from the USA grain industry. Many authors discuss mega farms in the context of Eastern Europe; a particularly interesting situation in the 1990s when much of the land mass moved from supporting a command/regulated economy to a market economy. This had a substantial impacts on the area of land under cultivation (Nguyen, 2018), farmer welfare (Sauer et al., 2012) and agricultural commodity prices (Sauer et al., 2012; Leifert and Leifert, 2007). Whether mega farms have emerged from the cost-price squeeze of agricultural production (Moss, 1992; Glau, 1971; Gruen, 1962) or the deregulation of government, the fact remains that they are holding an increasingly prominent place in the cadre of private enterprise that is feeding the world.

Implications: The disciplines of agricultural science and agricultural economics have been blessed with government-supported databases that have long-reported production and cost data. Cases in point include the Food and Agricultural Organisation's FAOSTAT, The Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) data sets, the UK's Farm Business Survey, the OECD's Eurostat data base and the international European Farm Accountancy Data Network (FADN). With the advent of supply chain, or value chain, thinking in agriculture, these databases are no longer providing the cross-section of data that is needed for in-depth supply chain analysis; simply because the collection often ends at the farm gate.

Supply chain management is "the management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole" (Christopher, 2005, p. 5). Supply chain thinking recommends collaborative, rather than adversarial, relationships so there needs to be a trusted, co-operation of sharing resources (and data) through the chain to enable value creation from this type of thinking. This complexity is not reflected in government-supported databases. With the emergence of mega farms and mega firms, researchers need to engage private enterprise (and *vice versa*) to provide data that will facilitate thorough advances in supply chain knowledge.

There are three factors of importance here: 1) private enterprises are assuming significantly more important roles in food production due to their increasing size (turnover and volume), 2) governments are investing less in agriculture as budgets tighten and 3) supply/value chain thinking is eclipsing production thinking in agriculture. As a result, there needs to be a paradigm shift in how agri-food supply chain data are accessed and how collaborative relationships are developed.

As consumers are demanding increasingly safe food that is produced under high phytosanitary standards, complex quality assurance programmes are facilitating vast quantities of data collection on inputs (nutrition, medicines, husbandry practices, etc.) and outputs (grow rates, slaughter weights, waste products, etc.). Increasingly, high animal welfare standards are an emerging area of interest and importance for consumers so, no doubt, this will become a

metric of quality along with existing free-range egg and pork production. All of this data that are being collected and stored by private enterprise and are thus inaccessible to researchers.

A demonstration of the value of this data is the work conducted by White, Carter and Kingwell (2018) on Australian grain supply chain. The research was particularly unique and valuable because of the access the researchers had to data from private enterprise. With this data, White, Carter and Kingwell (2018) were able to analyse the entire grain supply chain to develop important conclusions about how supply chain costs can be reduced in order for Australia to maintain competitive in the global market for grain. Cost variables within the analysis included logistics, handling, storage, port charges and levies; none of which are available from government-supported sources. Furthermore, the analysis was able to provide recommendations for future freight planning initiatives to ensure new infrastructure developments are fit for purpose and do not conflict with urban developments.

Conclusions: The objective of this paper was to discuss the changing nature of relevant organisations in the agri-food production sector and the impact this has on the availability of data for supply chain research. It has been argued that prominence is shifting away from governments which have led agri-food data collection in the past to the ultra-large mega farms and mega businesses that are emerging to feed an increasingly discerning and demanding global population. It has also been argued that publically-available data sets have been constructed on the production-view of agri-food systems. Now that we are taking an increasingly supply-chain view of food production, the data that have been collected in the past may not give an adequately broad view of the picture in which we are interested. The advent of increasingly sophisticated quality assurance schemes has facilitated the collection of massive data sets that are being held within private enterprise; all of which are useful to supply chain researchers. In so saying, private enterprise holds incredible value to supply chains in the data that it possesses and researchers are naïve to think that government-supported databases are sufficient to draw conclusions about entire agri-food supply chains. Christopher (2005) discusses the need for supply chain actors to develop trusting, collaborative relationships, principally because the whole is greater than the sum of its parts. The same thinking applies to the relationship between private enterprise and supply chain researchers.

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