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iDE
Cultivating Potential

Study on Strengthening Low-Cost Technology Market Systems:

Final Report

Report for the Swiss Development Cooperation (SDC)
Prepared by iDE-Bangladesh

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It is hoped that this work will inform and support good practice in agricultural technology commercialization for the benefit of poor rural communities in Bangladesh.

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Acronyms

AIS	Agricultural Information Services
ARIs	Agricultural Research Institutes
AUs	Agricultural Universities
BADC	Bangladesh Agricultural Development Corporation
BAMMA	Bangladesh Agricultural Machinery Merchant Association
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
BFRI	Bangladesh Fisheries Research Institute
BFRI	Bangladesh Forest Research Institute
BINA	Bangladesh Institute of Nuclear Agriculture
BJRI	Bangladesh Jute Research Institute
BLRI	Bangladesh Livestock Research Institute
BoP	Base of the Pyramid
BRAC	Bangladesh Rural Advancement Committee
BRRI	Bangladesh Rice Research Institute
BSRI	Bangladesh Sugarcane Research Institute
BSRTI	Bangladesh Sericulture Research and Training Institute
BTRI	Bangladesh Tea Research Institute
CGIAR	Consultative Group on International Agricultural Research
DAE	Department of Agriculture Extension
DCED	Donor Committee for Enterprise Development
DLS	Department of Livestock Services
DoF	Department of Fisheries
DoL	Department of Livestock
ESP	Extension Service Providers
FAO	UN Food and Agriculture Organization
GoB	Government of Bangladesh
HYV	High Yielding Variety
IARCs	International Agriculture Research Centers
ICT	Information and Communication Technologies
IPRs	Intellectual Property Rights
ISTA	International Seed Testing Association
LRI	Livestock Research Institute
M4P	Making Markets work for the Poor

MDG	Millennium Development Goals
NAEP	New Agriculture Extension Policy
NARS	National Agriculture Research System
NGOs	Non Government Organizations
NIB	National Institute of Biotechnology
RD&D	Research, Development and Demonstration
SAPs	Structural Adjustment Policies
SCA	Seed Certification Agency
SFB	Seed Federation of Bangladesh
SPs	Service Providers
SRDI	Soil Resources Development Institute
WB	World Bank
WIPO	World Intellectual Property Organization

Executive Summary

Improving the performance of the agricultural sector is a principal means of alleviating poverty amongst the most vulnerable and marginalized in Bangladesh. The adoption of **low-cost agricultural technologies** by small-holder farmers is widely understood to be a major driver of poverty alleviation and food security. Commercialization of new and existing technologies is increasingly being seen as the most effective means of enabling wide-spread adoption by farmers. Yet technology commercialization activities in Bangladesh are characterized by often fragmented and incompatible approaches with little coordination. In this the market system for technology commercialization can be seen to suffer from a number of **systemic weaknesses**. Interventions by development organizations in the market system to strengthen these areas of weakness can lead to major impacts in pro-poor growth and poverty alleviation.

Prepared by International Development Enterprises (iDE) for the Swiss Agency for Development Cooperation (SDC), this study provides a **picture of the technology market system in Bangladesh**. The study analyses the market system using an established market development approach[1], focusing particularly on identifying the problems around technology commercialization, the underlying systemic constraints, the key stakeholders and services which impact upon the system, and the key areas of the enabling environment for technology commercialization. This analysis enables the report to employ an **intervention logic tool**[2] to identify a number of entry points for **interventions which can be implemented to strengthen the market system**. Further recommendations are given on the how these interventions can be sequenced to maximize development impacts.

A methodology involving **literature review and field investigation** in a number of rural locations throughout Bangladesh was undertaken in mid to late 2011. Engagement focused upon triangulating information between the major actors in the market system to form a qualitative picture of the current situation and context. This included interviews with, amongst others, farmers, private sector companies and local retailers, and government research institutes and extension workers. Results were tested at both a large inception workshop and in a number of smaller validation workshops and interviews. This work highlighted a number of **key problems** in the market system. Broadly, these problems can be characterized as:

[1] The approach employed was the Making Markets Work for the Poor, an approach to development which focuses upon systemic market interventions (See 3.1 below for an overview)
[2] The Intervention Logic is a tool designed by iDE to focus interventions upon the underlying (systemic) causes of market weakness, rather than the immediate problems (or symptoms) observed (See 5.2 for details).

- **Informational** problems, such as farmers experiencing insufficient awareness of technology opportunities, inaccurate demand forecasting amongst the private sector, poor access amongst farmers to reliable information and advice, and farmers' lack of confidence in output markets reducing technology adoption;
- **Capacity** problems, particularly the skills base throughout the sector, the prevalence of piecemeal approaches (such as demonstration models) often driven by poor understanding of the full market system, and the continued presence of subsidy-based transfer and dissemination models;
- **Quality** problems, such as farmers lacking regular or optimal access to technology based services, farmers adopting poor quality technologies, and poor access to credit services which meet the requirements of certain technologies which can enable adoption; and,
- **Coordination** problems, such as the lack of a functioning Intellectual Property Rights (IPR) system and the absence of any coordinating body to champion a holistic view of the commercialization approach.

The problems identified enable the study to further identify the **key service areas** through which these problems can be addressed. The services represent areas of the market system which impact upon the core system of low-cost technology supply and demand. The identification of these service areas, in the **core supply and demand** as well as in the **supporting functions** and **rules** of the market system[3], allows for the technology market system to be articulated (see 7.2). It is proposed that interventions in these areas can serve to address the underlying causes of the problems and strengthen the market system. The key service areas were found to include:

1. **Farm Information Services** – the quality and availability of information accessed by farmers;
2. **Promotional Services** – the promotion of new products and services by both the public and privates sectors to farmers;
3. **Financial Services** – the quality, range, and flexibility of financial products available to low-income farmers;
4. **Market Information Services** – the quality and availability of information which can be used to inform business plans and development strategies; and,
5. **Coordination Services** – the championing of the commercialization approach and provision of leadership in the sector.

The identification of these key service areas allows for the entry points for **interventions to strengthen the market system** to be determined. These interventions are conceptual

[3] See 5.3 for an explanation of these terms.

frameworks for fuller interventions (with anticipated impacts and activities) to be designed and developed later. The recommended interventions are:

1. **Involvement of private sector in the design of Upazilla agriculture exhibitions**. It is felt that the incorporation of local domestic private sector actors into the established system of upazilla agricultural exhibitions would constitute a 'quick win' for the sector. The introduction of private sector stakeholders in collaboration with the public bodies responsible for the events would ensure that demand-side factors are fully integrated into the design and implementation of these important information sharing opportunities;
2. **Establishment of a Technology Needs Assessment Center**. The establishment of a center would function by continuously analyzing various agricultural sectors and acting as a technology hub to attract suitable technologies. The center would act as a champion for the commercialization approach, providing both a center for excellence and best practices in the sector and a base from which to lobby government and drive reform in the sector;
3. **Introduction of demand forecasting system**. This service currently does not exist in Bangladesh and would therefore need to be established. It is envisaged that this could take the form of a commercial venture where information is collected and stored in a database, with information transferred to consumers through a fee-for-service model. It is anticipated that the necessary market actors to drive both initial sources of demand and the necessary expertise to supply the information are currently available in Bangladesh;
4. **Introduction of agri-clinics**. It is clear that farmers need to triangulate information in order to test its quality. The introduction of agri-clinics would provide an impartial source of information which farmers could consult as required to give them confidence in what they are hearing from retailers and other market actors. This could also be implemented through the facilitation of market actors to deliver the service on a fee-paying commercial model; and,
5. **Strengthening of technology financial products**. The intervention recommends a service to add value to existing financial service providers through continuously matching financial support mechanisms to cater to particular technologies' requirements in order to establish them in the market system. Such coordination could ensure that financial service providers are continuously engaged in the development of new and innovative financial products, matching products with technologies, and supporting in developing and promoting new products.

1. Introduction

1.1 Overview

Improving the **performance of the agricultural sector is central to alleviating poverty** in Bangladesh. Agriculture comprises 20.6% share of total GDP in Bangladesh and the sector employs 48.4% of the labor force[4]. Most smallholder farmers remain poor and often lack access to the means to develop their livelihoods. They are disproportionately affected by food insecurity, climate change, and a decreasing land base per head of population. The development and uptake of low cost technologies bought unsubsidized through the market system has been shown to have a **transformative impact on poverty reduction**[5]. Commercialization is now largely understood to be the most effective means by which technologies can be scaled-up to reach large numbers of beneficiaries.

Yet Bangladesh is not currently maximizing its potential to **commercialize promising designs and new ideas**, leading to many technologies failing to enter the market and reach customers effectively. Rigorous market testing is required to ensure that new technologies can successfully enter the market and current research and development into the commercialization of technologies in Bangladesh often fails to consider all the factors involved in commercializing a technology. Key questions must be asked regarding how technologies can be sold, branded, and promoted, as well as regarding the strength of market linkages between actors throughout the value chain. Failing to address these questions leads to lower levels of uptake of a given technology, or failure to enter the market at all.

There is evidence that there are many technologies developed by research institutes (BARI, BRRI etc) which have yet to become commercially available to low-income farmers. While there is a lot of research into technology development and a number of good technologies exist, many are not being commercialized. This study seeks to **analyze the context of the market system for agricultural technologies in Bangladesh**. This study focuses on **understanding why technologies have not been commercialized** and will identify **focused and effective interventions** needed for the fast uptake of technologies. It undertakes this through considering the underlying systematic constraints around technology commercialization and identifying entry points for interventions to strengthen the market system.

International Development Enterprises (iDE) is an international NGO with a mission to create livelihood opportunities for poor rural households worldwide. iDE promotes a

[4] Government of Bangladesh, 'Bangladesh Proposal for GAFSP Funding', 2010
[5] See: Paul Polak, Out of Poverty: What works when traditional approaches fail. BK, 2009.

market driven approach to development and successfully implemented the market system development for treadle pump technology in Bangladesh[6]. iDE-Bangladesh is currently engaged in developing market systems in a number of areas, including in the areas of low-cost technology, water and sanitation, rural markets, conservation agriculture, and post-harvest. This study was developed as a result of iDE's approach to **strengthen technology commercialization systems** in order to achieve large scale change through the power of markets. IDE and SDC collaborated in this study to identify the interventions necessary to improve the adoption of technologies by farmers, and make them more competitive. It is envisaged that the interventions would be implemented in the near future in partnership with different stakeholders.

1.2 Objectives of the Study

The study has two broad objectives. These are to:

1. Analyze market systems, particularly:
    a. Problems around technology commercialization;
    b. Underlying systemic constraints;
    c. Key stakeholders (present and potential);
    d. Key services that need to be strengthened or established; and,
    e. Enabling environment.
2. Identify options and entry points for interventions.

1.3 Limitations of the Study

The study seeks to provide the most effective and actionable recommendations possible, though there are limitations to the study which are acknowledged. These limitations apply to both the methodology and the scope of the study and have been mitigated as far as possible. First, the study uses **qualitative data** derived largely from the self-reported accounts of market actors. While this opens the possibility of selective memory, exaggeration or attribution[7] compromising results, the study has been diligent in testing all reported data through triangulation with other relevant stakeholders in the market system. Second, the **scope of the study** does not allow for detailed information regarding how to implement identified interventions. Rather, the study identifies **which areas of the market system can be strengthened** and recommends outline interventions to better enable improved technology commercialization. It is beyond the scope of the study to

[6] Over 1.5 million pumps have been sold through the market systems in over 18 years in Bangladesh
[7] Where positive events and outcomes are attributed to respondents' own agency whilst negative events and outcomes are attributed to external forces

provide **details regarding required activities and likely impacts** of the recommended interventions on the system. It is anticipated that discrete pilot projects would be designed if there is interest in carrying forward implementation of the interventions.

2. Context

2.1 International Context

Food security remains a pressing global issue. In 2010 the worlds' undernourished numbered 925 million people and comprised some 16% of the populations of developing countries (The State of Food Security in the World, FAO, 2010). Recent food price spikes and falling income since the financial crisis in 2008 have worsened this situation. The UN estimates that the number of undernourished people may soon exceed 1 billion and that progress has become 'stymied in most regions' (MDG Report, 2010). Poverty and food insecurity are increasingly showing urban-rural disparities with rural poor more food insecure than urban populations, and rural children twice as likely to be malnourished as those in towns and cities (MDG Report, 2010). Many poor rural populations are disproportionately affected by climate change with rising sea levels and salinity, flash flooding, soil erosion, and extreme weather events causing further insecurity and damage to fragile local economies and ecosystems.

In this context **agricultural development faces a number of challenges in contributing to food security** in a way which is environmentally, socially and economically sustainable. Agriculture continues to place intensive pressure on fresh water consumption with 70% of global water extraction going towards irrigation. Fertilizers, pesticides and intensive farming practices contribute to land degradation, deforestation, and loss of biodiversity. Decreasing farm sizes per household amongst the poorest in many countries lead to greater pressure on land and more marginal yield to income ratios. As over 70% of the world's poor obtain income from agriculture in rural areas, and the incidence of malnutrition is higher in these areas, it is therefore clear that improvements in agricultural productivity aimed at small-scale farmers will make the greatest impact on food security and poverty reduction. The recent 2010 MDG Report states that the poorest and most remote have yet to be 'provided the conditions to improve their lives' and cites the benefits of technology transfer, pledging to 'make available the benefits of new technologies' in cooperation with the private sector (MDG Report, 2010).

The development and application of new agricultural technologies has been a key driver in increasing agricultural production worldwide. Although world population has more than doubled between 1950 and 1998 (from 2.6 to 5.9 billion), and harvested acreage per person has declined by half, grain production per person has increased by about 12 percent in this time (Brown et al. (1999) cited in Sunding and Zilberman, 2001). Technology transfer has acted as a driver of change, particularly in the period – broadly from the 1960s through the 1980s – known as the 'green revolution'. The introduction of

High Yielding Variety (HYV) and hybrid rice seeds (and other HYV vegetable seeds in conjunction with the associated management practices and an expansion of irrigation facilities) by government extension agencies, NGOs and private companies led to huge increases in food production, most particularly in Asia.

Key to the success of the green revolution was the coordination of an international system for technology transfer, in the consolidation of international research centers into the Consultative Group on International Agricultural Research (CGIAR) in the early 1970s (World Bank, 2008)[8]. Technologies widely used in developed countries (such as certain pesticides and synthetic fertilizers) or developed through the CGIAR centers (such as HYV seed varieties) yielded spectacular production increases when adopted en-masse in developing countries. Cereal production more than doubled in developing nations between 1961–1985 with India alone seeing annual wheat production rise from 10 million tons in the 1960s to 73 million in 2006 (ibid, 2008). While attention has been drawn to the focus on large scale agriculture, the increase in energy input as a ratio of crops produced, the negative externalities of the green revolution upon natural environment and biodiversity, and the socio-economic factors required to achieve food security (Sen 1999; Sunding and Zieberman 2001); it is nonetheless clear that the experience of the green revolution serves to demonstrate the transformative impact of successfully facilitating the process of technology transfer at scale in developing countries.

Recent literature is calling for another 'green revolution' to address food security issues. Where the green revolution is a story of technology transfer from North to South and South to South (WB, 2009), increasingly literature is exploring the potential for greater flows of technology from South to North. Current thinking around low-cost technologies see the base of the pyramid (BoP), or the poorest and most marginalized in the world economy, as an incubation area where low-cost technologies can first be embedded and then be transferred to developed economies (Hart, 2010). Hart (2010) contends that advanced green technologies and BoP ventures have developed largely in isolation from each other, with BoP ventures often failing to cater for environmental factors effectively and research into green technologies failing to commercialize products to reach the high volume market at the BoP. Freed from the vested interests which serve to protect large asset bases of often highly polluting and resource intensive technology systems in the rich world, the BoP market offers a context in which innovation can thrive and eventually be adopted by developed economies. Hart argues that merging these approaches in to a **'Green Leap'** 'holds the potential to adapt and commercialize the most advanced green technologies from the rich world in the underserved spaces in the BoP. Once established,

[8] World Bank 2003; Gagnun-Lebrun 2004; Pardey, Beintema, Dehmer, and Wood 2006 in World Bank, 2008: 27

such technologies and business models could then 'trickle up' to the established markets at the top of the pyramid – but only after they have proven themselves to be reliable, affordable, and competitive in comparison with the existing infrastructure (Hart, 2010).

2.2 General Issues around Technology Market Systems

The economic character of agricultural information can be classified into different categories in order to understand the incentives of the actors involved in delivery. The incentive structure for this is dependent upon the source of funding, broadly public or private, and whether extension is delivered by public or private bodies. This classification is described in Table 2 (below), which shows a picture of mixed strategies of the public and private sector actors in the system. Generally private firms are unwilling to supply goods and services with 'public-good' characteristics as restricting the benefits derived from those goods only to those who paid for them is usually impossible. A farmer will not be willing to pay for information on soil conservation techniques that are also being reported by radio, because other farmers can freely obtain the same information (Umali-Deininger 1997). However, this classification becomes less clear cut in the case of some technologies. While Umali-Deininger (1997) argues that modern technologies are private goods due to the presence of legal mechanisms (patents, copyrights etc) which provide 'a high degree of excludability' the context of developing countries where technologies such as threshers, shellers and simple manual technologies (such as USG applicators, weeders etc) are counterfeited by many local level manufacturers, means such technologies are less-excludable. In this context even public institutions will develop technologies on the understanding that local level manufacturers will replicate them and stimulate the market for the product. Even though the notion of excludability does not apply in this, private manufacturers[9] have contributed largely in commercializing technology transfer to the rural farm households. This situation often results in mixed strategies being employed to provide extension services in developing country contexts.

[9] In this case, private manufactures are local level entrepreneurs who have small engineering workshops that produce technologies. These are not in the industrial category rather having the features of small enterprises.

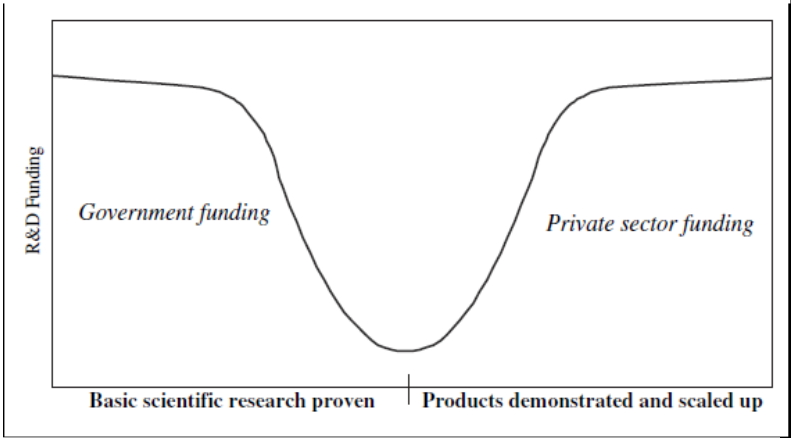
Table 1. Mixed Strategies for Financing and Providing Extension

Funding \ Delivery	Public	Private
Public	**A.** Free public extension service	**B.** Subsidies to private extension, extension contracts, voucher schemes etc.
Private	**C.** Cost recovery by government agents.	**D.** Private enterprise.

Source: Kidd et. al. 2000:97 *cited* Upton 1992.

It is widely understood that **market systems offer the most effective means of replicating, disseminating and ensuring the uptake of new technologies** (Polak, 2008; Wolf, 2004; Bhagwati, 2004). Yet the literature points to many weaknesses in the technology market system which inhibit the uptake of new and innovative agricultural technologies by BoP markets. These weaknesses have led to substantial amounts of agricultural technologies, developed particularly by public and quasi-public agencies such as the national agricultural research systems (NARSs) and the international agricultural research centers (IARCs), not becoming transferred or commercialized at scale (Gelaw et al., 1997). There are a number of common issues which contribute to this context. Acquah & Gelaw (1997) note that **in many cases attempts at technology transfer and commercialization can be supply driven**. They assert that efforts towards agricultural research and technology development and adoptions [in Sub-Saharan Africa] have occurred without the useful participation of end-users (farmers, input business, and processing firms) and transfer agents (extension officers) (Acquah & Gelaw,

Figure 1: The 'valley of death' scenario



Source: World Bank, 2008

1997). Further this has often **misdirected interventions**, with the dissemination of such 'top down' information often favoring male farmers and neglecting women, who do the bulk of agricultural production work in many societies. Also, this process can cause further problems even when technologies have been successfully transferred, as often the supporting environment required to make these technologies sustainable has not been sufficiently considered, leading to a lack of access to credit or other inputs required to secure the adoption of given technologies (Acquah & Gelaw, 1997).

A key issue is when private and public incentives structures do not align to support product commercialization. The World Bank has drawn attention to the period in product development between public and private sector involvement when 'promising technologies languish between public and private sector RD&D [Research, Development and Demonstration] efforts' (WB, 2009). This **'valley of death' scenario** occurs as government driven research agencies, which often begin the process due to the high risks and uncertain returns inherent in the early stages of technology research and development, disengage from the process as the technology begins to show signs of commercial viability, as public agencies do not want to subsidize industry or distort markets. However, the private sector often still sees too much risk to take up the product development process due to the high initial cost to return ratio of developing and refining prototypes for commercial production (itself referred to as the 'mountain of death'[10] of technology development costs). Although the gap is not insurmountable (through for example additional public, private or combined efforts), it inhibits the progress of promising technologies to the demonstration and scale up stages needed to achieve full commercialization and often causes 'seriously delays' to commercialization (WB, 2009). **Intellectual property rights (IPRs)** can play a key role in providing incentives for innovation, both for innovators (who can receive royalties) and disseminators (companies can be protected from counterfeiting and forgeries). Yet the WB points toward the 'imperfect nature and uneven distribution of information between different innovators as well as between users and producers of technology' in many developing countries, and the uncertain reach of global IPR protection which undermines these incentives (ibid, 2009).

[10] The process of rising and then falling per-unit costs is referred to as the 'mountain of death' for new technology innovation. The first full integration of the components of a new technology represents the highest per-unit cost that the developers will likely face. As more is learned about both 'the system as a whole and the individual components, and as economies-of-scale are achieved in the manufacturing costs, per-unit costs will fall. Eventually the technology reaches maturation, at which point the per-unit costs will be sufficiently low and technical reliability will be sufficiently high to warrant continued manufacturing of a commercial product.' (WB, 2009)

2.3 Bangladesh Context

The modern narrative of interventions to stimulate technology transfer in Bangladesh can be understood as comprising four key historical periods. Since the formation of the country until around 1980 we saw a **heavily public sector-led system** in which policy-makers in the new country engaged in centrally planned, government dominated interventions to stimulate agricultural productivity. In the 1980s through until 1992, the **emergence of private sector operators** in the system was largely the consequence of structural adjustment policies (SAPs) adopted by the Government of Bangladesh (GoB) in collaboration with donor agencies such as the World Bank. This period saw deregulation of farm inputs and a widening of investment options available to the agricultural sector, despite the system remaining largely dominated by the public sector and Non Government Organizations (NGOs). From 1993 until the the late 2000s we can observe a **deepening of private sector activity** in the technology transfer system built upon the previous deregulation and the **emergence and of a decentralization process** as donors facilitated linkages between farmers, NGOs, the private sector, and the GoB, primarily through the Department of Agriculture Extension (DAE)[11]. However activities driving the decentralization system have now stopped since the end of the project duration in 2003. This leads to the present situation where instances of private sector-led models, subsidy models, and hybrid private-public models exist in the system. It is clear from the historical narrative that the eras of public-led delivery, private-led delivery, decentralized research models, have featured the GoB as the driving force behind research and transfer activities. **Yet these interventions have consistently been undertaken as responses to immediate problems rather than seeking to address the underlying causes of weaknesses in the full system.**

1971 – 80 Public-led

- Duplication of public efforts
- Government dominated
- Transfer system neglected educational component in favor of inputs and credit

As Bangladesh emerged from both the shocks of both its violent formation and the devastating famine of 1973, **huge expectation was placed upon public intervention to increase agricultural productivity.** At this time six government agencies existed with

[11] The project has three phases: the Agricultural Support Services Project (1992-1995); ASSP Extension (1996-1999); and the Agricultural Services Innovation and Reform Project (1999-2003).

functions related to crop production[12] and the role of extension organizations was understood as largely to facilitate the supply of input and credit functions to farmers. While the extension worker-to-farmer ratio was very low (to the extent that a field level extension worker as responsible for providing services to 2-3,000 farm families), the system was hindered had a number of structural flaws. The duplication of efforts by six public agencies working separately often led to confusion among extension staff about their responsibilities. Also the transfer of 'hard' technologies and credit through the government extension services generally subordinated 'soft' technologies such as the educational role of extension. As technologies were under government monopoly and the extension service mostly controlled by the public sector, **the system served to limit the choice of farmers to the areas of support they could receive**, with priority areas (jute, sugarcane, tobacco and horticulture at the time) being decided and prescribed centrally. Efforts were made to coordinate areas of the system, such as the establishment of the Bangladesh Agricultural Research Council (BARC) in 1973 with the aim of coordinating systematic agricultural research in Bangladesh, the period can be understood as being largely influenced by the general assumption from colonial times that that agricultural extension is both a public good and a government responsibility (Hulme 1983 *cited* Leonard, 30 p. 3).

1980 – 92 Emergence of private models

- Emergence of private sector though system still dominated by NGO and public sector
- Rationalizing market as a part of structural adjustment policies (SAP)
- Deregulation in seed, farm machinery, fertilizer
- Focused on contract farming (large farmers) – which did not 'trickle down' to poor farmers as expected

In collaboration with the World Bank and other international institutions, **the1980's saw structural reform of the economy combined with further efforts to streamline the system of agricultural extension and technology transfer.** Consistent with the contemporary trend of the rise of the 'new right' in global development discourse, this period saw increasing pressure from donors for increased economic liberalization, leaner government, and market deregulation. This pressure influenced major reforms in a number of sectors, such as seed, through the end of compulsory variety registration in crops other than five notified crops: paddy, wheat, sugarcane, jute and potatoes (1990); fertilizer and pesticides, with the liberalization of import by brand names (1989) and

[12] Directorate of Agriculture (Extension and Management), Directorate of Agriculture (Jute production), Directorate of Plant Protection, Horticulture Development Board, Central Extension Resources Development Institute, Tobacco Development Board

removal of permits for phosphate imports (1990); and machinery, with the elimination of import taxes on standardized diesel engines and power tillers (1988), and the end of standardization (1989). This opened up new spaces for private entities in the input business and accompanied extension services (Zahir 2001; Gisselquist *et. al.* 2002). Market deregulation also came with changes in the policy and extension regime regarding agricultural technology transfer. A single point of contact for agricultural extension was established through the creation of the DAE, where six major government agencies were brought under a single umbrella, and stronger linkages between research and extension were developed with various technical committees being established at different levels of the system (Hassnullah, 2004). While these developments facilitated the emergence of private sector service providers (SPs) and NGOs promoting their products with the extension service, **the agricultural extension system in Bangladesh remained reliant upon public funding through donor supported programs**[13]. Although the country experienced improvements in the yield of certain crops (particularly rice) over this time period, the model of over-centralized planning and top down development and dissemination of extension services ultimately failed to accommodate the service requirements of poor farmers as it favored the delivery of technologies to larger contract farmers who were non-poor (ASSP & ASRIP, 2003a).

1992 – 2008 Emergence and decline of the decentralization process

- Donors facilitated linkages between NGO, private and DAE (project-led)
- Multiplication of private sector extension services due to previous deregulation
- Donor support to public sector extension dried up
- Emergence of research prioritization system even though the recommended process did not address potential public-private collaboration

The 1990s saw a deepening of private sector involvement in the technology transfer system with an emergence of a more 'grass-roots' focus in agricultural extension. Huge increases in production were experienced due to farmers' benefiting from better access to irrigation facilities as well as high yielding variety (HYV) seeds in both the paddy (rice) and horticulture sectors. Private sector extension services multiplied during this period as the effects of previous deregulation gave new confidence to private sector operators. The GoB updated its policy position through the adoption of the New Agriculture Extension Policy (NAEP) that aimed at removing the limitations of the previous

[13] Since the late 1970s through to the end of 2003, donor agencies in Bangladesh invested around US$ 88 million in three consecutive extension development projects (World Bank, 2003; World Bank, 2005; ASSP & ASIRP 2003a, 2003b; Gill et al., 2003).

top-down approach. The NAEP sought to introduce a demand driven extension service through decentralization as well as group extension method. Various national, meso (middle) level as well as local level committees were formed to have bottom up planning and implementation process, and a problem census and farmers need assessment (FINA) system was introduced. One of the key features of this period is the embedding of a contracted partnership system whereby NGOs were funded to work side by side with the DAE on agricultural extension. **However, government services, research and extension linkage remained donor-project dependent** and the limitations of this model became apparent in 1999 when the DAE-NGO liaison committee ceased functioning and contractual partnership among NGOs and DAE declined in line with the reduction in funding. By the mid 2000s it was clear **that organizational reforms were unsustainable as often interventions did not continue after the period of program funding**. Several factors also have been identified as contributing to this, including: the project mode of donor-support in the DAE, the creation of parallel structures to implement reforms, the high transaction costs of maintaining new structures, a lack of operational budgets, the difficulty of maintaining staff morale with low salaries, the uncertainty with financial decentralization within GoB ministries, problems around the GoB to re-finance the reforms through revenue budgets, and limited staff incentives (ASSP & ASIRP, 2003a, 2003b; Gill et al., 2003; World Bank, 2003; World Bank, 2005).

2009 – 2011 The Current System

- Private sector extension services have not reached BoP
- Few instances of deregulation now
- Technology transfer remains uncoordinated and fragmented
- The GoB is making efforts to coordinate the prioritization of research through BARC's Vision 2030 document

The history of technology transfer in Bangladesh reveals both success factors and ongoing issues in the system. It is clear that the instances of deregulation in the 1980s led to increased production once embedded in the 1990s and after. Increases in private sector involvement in research and extension have also led to increases in production, particularly in the period immediately post-deregulation. **However, these successes have not been replicated uniformly and a number of issues persist.** These include that a settled technology transfer system has yet to be achieved, with linkage between research and extension remaining very poor; private investments into the technology transfer system are still very weak; and, investments are much less evident outside donor funded projects (Chapman & Tripp, 2003). Furthermore, the process of deregulation appears to have stopped since donor pressure has relaxed, and that deregulation has failed to reach

the BoP markets where most of the instances of poverty and food insecurity are located. **Efforts are currently underway to coordinate and prioritize research.** In 2011 the context of technology transfer in supporting agricultural extension in Bangladesh remains characterized by residual coordination problems and the presence of fragmented and often incompatible approaches. Despite the various efforts undertaken to integrate and coordinate the research and extension system within the country the system in Bangladesh remains the remit of five separate ministries. BARC currently acts as the apex body of the National Agricultural Research System (NARS) coordinating eleven agricultural research institutions[14]. BARC's Vision 2030 strategy outlines the key priority areas for technology funding by the government, this is undertaken through 12 subsector studies[15] (2010-11) in the areas of farm machinery, irrigation, and postharvest technology.

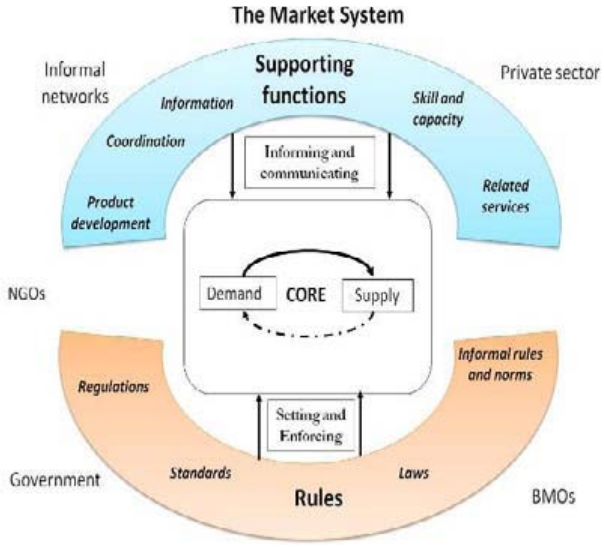
[14] Bangladesh Agricultural Research Institute (BARI), Bangladesh Rice Research Institute (BRRI), Bangladesh Jute Research Institute (BJRI), Bangladesh Institute of Nuclear Agriculture (BINA), Bangladesh Sugarcane Research Institute (BSRI), Soil Resources Development Institute (SRDI), Bangladesh Fisheries Research Institute (BFRI), Bangladesh Livestock Research Institute (BLRI), Bangladesh Forest Research Institute (BFRI), Bangladesh Tea Research Institute (BTRI), Bangladesh Sericulture Research and Training Institute (BSRTI). (For further details see: Appendix 1: Public Sector Agencies in Agriculture)

[15] The Vision 2030 document outlines 12 subsectors, these comprise (in no particular order): (1) rice; (2) cereals other than rice, sugarcane and jute; (3) horticultural crops, such as potato, fruits, vegetables, and spices; (4) pulses and oilseeds; (5) soil and fertility management; (6) forestry; (7) livestock; (8) fisheries; (9) agriculture mechanization and water management; (10) ICT in agriculture; (11) agriculture economics, marketing and supply-chain development; and, (12) technology development, agro-processing and post-harvest technology, food quality and human nutrition.

3. Conceptual Framework for the Study

3.1 M4P Approach

Figure 2: The Market System



Source: Springfield Centre: www.springfieldcentre.com

It is crucial for any study of technology market systems to have a **clear understanding of the concept of market system thinking**. iDE's understanding of market systems is consistent with the 'Making Markets Work for the Poor' (M4P) approach which exemplifies emerging thinking in enterprise development and is endorsed by the major partners of the Donor Committee for Enterprise Development (DCED). The M4P approach seeks to make markets work more effectively, sustainably and beneficially for poor people. It requires that development agencies and other external actors play a facilitation role in the market system that is temporary and catalytic. M4P proposes that by addressing the underlying causes of weak market performance, interventions can leverage the power of markets to bring about large-scale change.

M4P posits that any market system will not function optimally if the actors have specific problems at any level. The market schematic (see Figure 2 above) presents the market system as comprising three distinct but inter-related areas. These areas comprise: (1) the **core services** (center) – are the interactions which satisfy supply and demand which forms the core activity of the market system. This core activity is the space where the main transactions, exchanges of goods, products and services, all take place. (2) The **support services** (blue) – are the basis from which the core activity takes place. It refers to services provision which can range from government provided services such as infrastructure to market provided services such as research and accounting services, technology provision, and legal. Such supporting services are crucial to support the market system as weaknesses in the support services can hinder the growth of businesses in the core service. (3) The **regulations/ rules** (red) – are the regulatory environment and/ or informal rules of business which affect the core activity. This could include government policies, standards and regulations as it relates to all transaction activities within the market system; also there are informal rules that are determined by social traditions and customs

which can affect the core service. It is therefore crucial in to identify inhibitors in the regulatory environment so these can be addressed to support the core activity.

As this understanding of the market system posits that the core activity is dependent upon supporting and regulatory services to function, it is important when designing development interventions to identify and address the underlying causes rather than symptoms of market failure. The supporting functions and the rules allow the core value chain to move efficiently. It is thus critically important to work around the supporting functions and/or the rules that allow the products to move efficiently in the value chain. The idea being if some of these functions have lapses and prove to be ineffective it affects the inputs, production and ultimately the output of the products. Therefore it can be understood that the **underlying causes of the problems are the lack or failure of specific services** to ensure the regular movement of products.

3.2 Components of the Technology Market System

iDE understands the technology market system as comprising **three component systems**. The related **research, transfer and commercialization** systems must function effectively in order for the commercialization of low-cost technologies to occur.

Research is the starting point of any technology that needs to be commercialized. However, the effectiveness of research is still a question that needs to be answered. Research can be understood as the creation of new and promising technologies. There are different approaches that the private and public sector undertake when research and development are being conducted.

Technology transfer has been defined as the process of movement of technology from one entity to another (Souder et al. 1990; Ramanathan, 1994). This movement may involve physical assets, know-how, and technical knowledge and in some situations may be confined to relocating and exchanging of personnel or the movement of a specific set of capabilities (Bozeman, 2000; Osman-Gani, 1999; Lundquist, 2003). Technology transfer has also been used to refer to movements of technology from the laboratory to industry, developed to developing countries, or from one application to another domain (Philips 2002). Where technology is considered as

Figure 3: Components of the Technology Market System

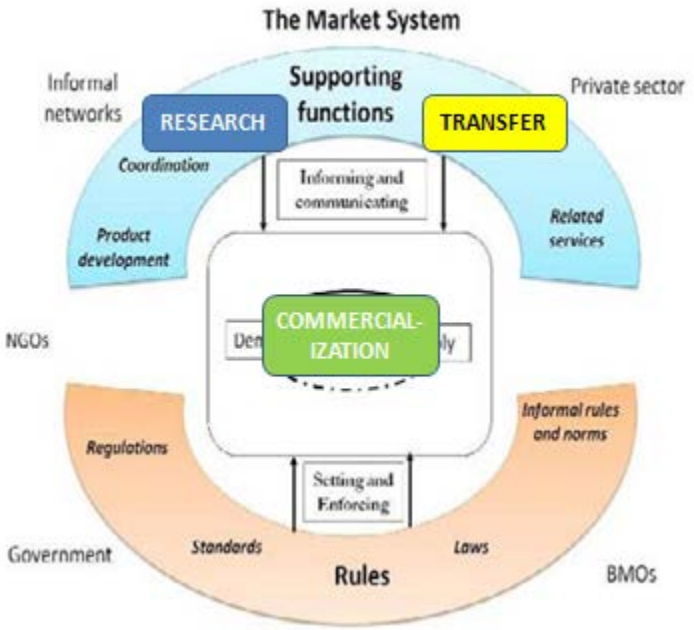
information, technology transfer is sometimes defined as the application of information into use, raising questions around the properties of basic knowledge and their relation to product design (Gibson & Rogers, 1994; Arrow, 1969; Dosi, 1988).

Technology **commercialization** has been generally understood in transactional terms as a process where goods and services regarding technologies can be sold for payment. However the commercialization process is more than just the selling of goods. Acquah & Gelaw (1997) contend that the sustainability of a product and its contribution to social values in producing self-sufficiency should be taken into consideration when defining commercialization (Acquah & Gelaw, 1997). **Sustainability is central to any understanding of commercialization** as products require evolution (market responsiveness) in order to remain sustainable in a given marketplace. This often requires the interaction of many actors and the support of an institutional framework which can co-evolve with the innovations coming from industry and research (WB, 2009:11).

3.3 Understanding the Technology Market System

There is evidence that there are many technologies developed by ARIs (including BARI, BRRI etc) which have yet to become commercially available to low-income farmers. A focus on **understanding why these, and other, technologies have not been commercialized** will enable **more focused and effective interventions to be identified**. As shown above the component Research and Transfer systems have been in existence since the 1960s, and many of the actors involved in these systems exhibit well established modes of operation. Yet the Commercialization System is a relatively new conceptual approach to understanding the wide-spread adoption of technologies by poor farmers and currently an under-researched area.

Figure 4: The Technology Market System



It is therefore useful to conceptualize the market system for commercialization of low cost technologies in Bangladesh in a model where **the component Research and Transfer Systems enter the Supporting Functions of**

the Technology Market System (see Figure 4). In this model the Research and Transfer systems fit in the overall Commercialization System as supporting functions between consumer demand (farmers) and the supply (providers of technologies such as private sector, government, NGOs). In this conceptual framework, the study seeks to identify entry points into the commercialization system rather than in the component research and transfer systems.

Research

The creation of new and promising technologies

Technology Transfer

The movement of technology from one entity to another

Commercialization

The models by which technologies and services become available to the target market

3.4 Agricultural Technologies

In order to understand the process of technology commercialization **it is useful to consider the kinds of technologies which are relevant to the focus of the study**, technology market systems in agricultural production. According to the World Intellectual Property Organization (WIPO) **technology** is defined as 'the systematic knowledge for product manufacture and service provision in industry, farming and commercial fields'. This refers to the application of science to accomplish certain functions as reflected in inventions, utility models, designs, and data forms (APCTT). In this definition technologies can therefore be physical, informational (knowledge based), and a means to access services. Low cost technologies refer to the affordability of a given technology for low-income rural populations as a ratio to value rather than an absolute number related to specific income indicators of development (for example those on US$2 per day). Therefore, for the purpose of this study, '**low-cost technology' can be defined as something physical, knowledge-based, or a new or innovative means to access services for low-income (BoP) consumers.**

Rather than focus on individual technologies however, this study will draw upon a **classification of innovations according to form** as outlined in Sunding and Zilberman's (2001) discussion on the agricultural innovation process, which offers a useful thematic lens through which to analyze the key actors and their capacity and contribution to the commercialization system (Sunding & Zilberman 2001). This classification defines

technologies in five categories, comprising: (1) **biological** technologies, those which deal with developing new varieties of biological components in agriculture, such as new seed varieties; (2) **mechanical** technologies, physical tools which are usually used in pre and post harvest as well as on-farm production, and could include for example tractors, seed planters, and combines; (3) **chemical** technologies, agro-chemicals including fertilizer to pesticides; (4) **agronomic** technologies, dealing with product specific management practices and including for example fertilizer management practices for certain crops; and, (5) **bio-tech** technologies, denoting advanced scientific innovations that deal with genetic modification, such as GM crops. In addition to these categories, and following (ibid, 2001) another category can be added, that of (6) **informational** technologies, denoting the use of ICT to develop technologies that provide analytical information on above mentioned technologies, this could for example include new methodologies for understanding the economic impact of a farming system. This classification provides a thematic lens through which to understand the key technology areas in which innovation and commercialization occur.

Table 2: Classifications of Agricultural Technologies

Classification	Definition	Example
Biological	Deals with developing new varieties of biological component in agriculture.	New seed variety
Mechanical	Mechanical technologies are usually used in both pre and post harvest as well as on farm production. This includes farm machinery.	Tractors and combines
Chemical	Agro-chemicals can be ranging from fertilizer to various kind of pesticides, growth regulators etc.	Fertilizer and pesticides
Agronomic	These technologies deal with product specific management practices.	Fertilizer management practices
Biotechnological	Advanced scientific innovations that deals with genetic modification.	GM crops
Informational	Using ICT, technologies can be developed that has analytical information on above mentioned technologies.	Economic impact of any farming system

4. Key Actors in the Technology Market System in Bangladesh

To understand the overall technology market system for low-cost technologies it is useful to understand the key players involved in the system. Due to the number of different public and private sector actors involved in the conception, production, and dissemination of technologies it is not possible to map each individual actor; nor is it necessary or desirable to detail the journey of each individual technology as it moves from concept to commercialization. Rather, it is useful to consider the status, capacity and contribution of actors within the market system.

4.1 Public sector actors, capacity and contribution[16]

The public sector is central to the technology market system in Bangladesh as it provides research, technology transfer, regulatory governance, coordination, and service provision to the agricultural sector. The public sector has huge resources and capacity in research and extension, and a mandate to provide a regulatory framework which enhances agricultural production, safeguards the environment, and benefits the people of Bangladesh. The vast majority of research and development into new and innovative agricultural technologies is undertaken by the public sector, often in collaboration with the NARCs, other international bodies, NGOs, and the private sector.

The Agricultural Research Institutes (ARIs) are the predominant agencies producing innovations in agricultural technologies in Bangladesh, providing the primary research and development function of the GoB in agricultural development. The ARIs are mandated according the priority aspects of agriculture which have developed throughout Bangladesh's recent history, and currently **comprise eleven institutes** focusing upon the research areas of: agriculture, rice, jute, use of nuclear energy in agriculture, sugarcane, forestry, livestock, fisheries, tea, sericulture, and soil. A number of technologies originating from these ARIs have been successfully commercialized and have made a substantial contribution to agricultural production, most particularly innovations in rice production. These technologies include biological and biotechnological seed varieties such as BR-28 and BR-29. An overview of the focus areas for the ARIs is provided in Appendix 1. The Bangladesh Agricultural Research Council (BARC) is the apex body which coordinates the ARIs, though a total of four separate ministries are involved in the technology system. Indeed, although BARC is the coordinating body of the ARIs, management and funding remain totally controlled by these ministries.

[16] Drawn from FAO 2011 and the websites of the ARIs.

Public Extension Service Providers (ESPs) are mandated to provide extension services throughout the country and exist to promote agriculture, through the Department of Agriculture Extension (DAE); livestock, through the Department of Livestock Services (DLS); and fisheries, through the Department of Fisheries (DoF). Of these the DAE is perhaps the most notable for its scale and relevance to technology transfer. Under the Ministry of Agriculture, the DAE operates a subsidized business which provides seed, vegetable seedlings, and ornamental plants for sale to the public through a network of 75 horticultural nurseries. DAE has large capacity to undertake extension work across Bangladesh, with as many as 12,000 extension staff in its field services wing.

Other key players in the agricultural technology system are the Agricultural Universities (AUs), Bangladesh Agricultural Development Corporation (BADC), the National Seed Board (NSB), the Seed Certification Agency (SCA) and the Livestock Research Institute (LRI). These actors play a number of roles in the system including developing new varieties of seeds and collaborating with the private sector for delivery (AUs; BADC); acting as statutory bodies providing certification services and approvals (NSB; SCA); and providing technology transfer services directly to farmers (LRI; BADC). Of these actors the BADC is notable for its scale and reach into local areas. The BADC supplies about 20 percent of Bangladesh's cereal seed requirements and about 2–5 percent of seed of other crops (FAO, 2011). It directly employs farmers, using almost 60,000 smallholders as contract growers for production of certified seed, and has about 1,300 licensed dealers for marketing certified seed, including registered private seed dealers and NGOs.

4.2 Private sector actors, status, capacity and contribution

The **bulk of the literature regarding private sector involvement in technology commercialization focuses upon the seed sector**. This is likely due to much of the literature in the public domain being generated by the public sector which has been predominantly focused upon this area since the green revolution period. While farm mechanization has been an area where the private sector has also been active, little literature on the private sector activity within this area exists. Therefore, the study draws heavily upon the existing literature on the seed sector as representative of the private sector involvement in the technology market system.

Since the deregulations in the 1980s and 1990s, the role and presence of the private sector has been increasing in technology production and multiplication. There are some 3,126 registered seed dealers in Bangladesh[17], and the number of private companies with research capacity has been growing. At least four private companies have established

[17] http://www.moa.gov.bd/seed/seed_dealers.htm

facilities for plant breeding and seed processing (ibid). Some private companies are involved in multiplying seed from foundation seed received from BADC and breeder seed from the ARIs, and have established a network of seed growers. However, most companies import seed and sell through dealers. Many private seed companies have experienced rapid growth in recent years. The major players include *Lal Teer*, which employs 16 breeders (for all crops) and nearly 25,000 contract growers for seed multiplication and through these contracts it provides employment to about 100,000 female laborers for cross-pollination; *Supreme Seed*, which started operations in 2005 and employs ten breeders to work on short-duration summer tomato and rice and maize hybrids; and *Aftab Seed* which, with nearly a dozen other established businesses, has recently started producing vegetable seed[18]. The growth of private sector in **poultry, livestock, dairy** and other agribusiness is also increasing. Typically these large scale agri-business enterprises are involved in contract farming[19] and provide extension services to contract farmers.

In recent years the private sector has grown increasingly assertive in protecting its interests and representing itself to government. There are about sixty private seed companies in Bangladesh, and they have formed a number of associations, such as the Seedmen's Society of Bangladesh, Bangladesh Seed Merchants' Association and the Bangladesh Seed Growers' Welfare Association. In 2003, the seed associations formed the Seed Federation of Bangladesh (SFB) to represent the business interests of the private companies and influence the Government in seed-related policy issues. About seventy to eighty percent of vegetable seed used in Bangladesh for commercial production are imported. There are about fifty private importers of vegetable seed.

Private companies are increasing their research capacity to undertake their own development of new agricultural technologies. Several companies have established vegetable breeding facilities, notably *Lal Teer* and *ACI*. *ACI* initiated production of rice, potato and vegetable seed in 1997 on a small farm in Bogra and has established collaboration with BAU, BSMRAU and private companies from China, India, Italy and Thailand. *Lal Teer* has an 18-ha experimental farm in Gazipur district with facilities for seed drying, cleaning, controlled dehumidified storage and seed packaging and a mini-gene bank with more than 3,000 accessions of local and foreign germplasm. The large scale of many of the private companies means that they make a significant impact upon the research and technology transfer system, changing the landscape of market actor. *Lal Teer* has succeeded in developing some 70 varieties of various vegetables, including nine hybrid varieties.

[18] Including Ispahani, Energypac, Square, Paragon, Northern and Partex,
[19] Contract farming can be many forms in this regard e.g. seed production, raw material production for processing etc.

Bangladesh has several thousand NGOs of which around 20 are primarily involved in agricultural production and marketing. NGOs in Bangladesh feature the capacity to be major players in the agricultural sector, often able to leverage donor funds and capitalize upon existing dissemination channels and links to local communities. Many NGOs operate in the manner of research organizations, creating and releasing new technologies into the market. These include BRAC, which has released four hybrid seed varieties and has five more under development[20]. However, the reliance of NGOs to deliver agricultural extension services through donor funded projects raises issues of sustainability, as often service provision ends with the completion of the project. Indeed, the UN has recently voiced the concern that: 'the extent and quality of NGO involvement in seed production varies substantially, and there are debates about how well the NGOs balance their philanthropic, microcredit and commercial objectives' (FAO 2011).

[20] In 2007, BRAC produced 1,337 tons of seed of hybrid rice varieties and 61 tonnes of inbred rice seed; 868 tons of hybrid maize seed; 71 tons of vegetable seed, and 3,815 tons of potato seed.

5. Analytical Approach

5.1 Engagement

Engagement was undertaken with key respondents from August to November 2011 throughout Bangladesh. This work served to investigate the key intervention areas and provide further information on specific questions outlined for each sector, with a particular focus on the commercialization system. Representatives from a number of organizations were understood to be relevant respondents for the study; therefore **open ended interviews** were undertaken with a range of stakeholders, including:

a. Policy makers e.g. heads of the public and private stakeholder organizations;

b. Scientists e.g. scientists who have developed technologies;

c. Private entrepreneurs e.g. representatives of companies, manufacturers, service providers; and,

d. Farmers and other end-users of technology.

Stakeholders engaged to provide information on the **commercialization** system were varied and numerous. These included representatives of public and private distribution networks, particularly companies who promote and sell their products through large scale distribution networks. These dealers and retailers hold the key in making technology available at local level and have been providing non physical/ informational technologies to farmers. Notably engaged organizations include the Hortex Foundation, which has been lauded for its many successful practices within the country in technology commercialization, and the Bangladesh Agricultural Development Corporation (BADC), which as the predominant public sector player in the seed market is a key respondent in understanding the flows of technology through transfer to commercialization.

Specifically, on the **research** level interviews were conducted with key ARIs like BRRI, BARI, BARC, BFRI, BLRI, SRDI, BJRI and BSRI. As many private sector organizations have research capacity interviews were undertaken with private companies in order to gain an understanding of the overall private sector research system. Also agricultural universities have research capacity despite not being directly attached with the NARS system.

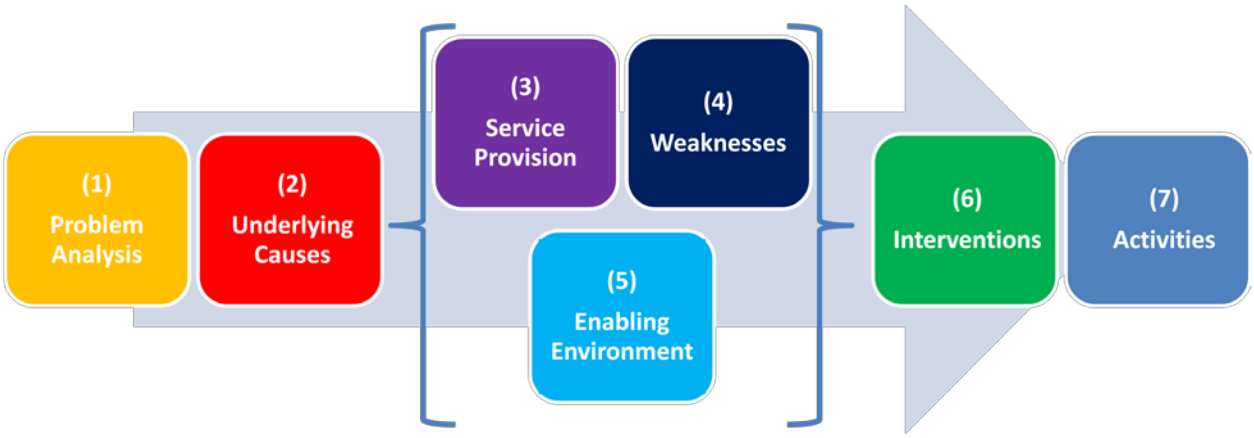
In terms of **transfer and dissemination**, interviews were undertaken with key public extension service providers DAE, DoF and DoL, and also with ARIs, which also have a mandate to transfer and disseminate technologies. NGOs and development partners were interviewed, as they can play a key role in the transfer and dissemination of agricultural technologies, of particular interest being the sustainability features within interventions and the underlying process and preference of financing in the technology system. Also

representatives of the Rural Development Academy (RDA) were interviewed as the RDA conducts research on various issues of rural development that inform policy formulation by government.

5.2 Intervention Logic

iDE utilizes an **intervention logic** to address the underlying causes rather than the symptoms of poverty. The intervention logic comprises a seven stage methodology. Broadly it can be understood as follows: (1) a problem analysis is undertaken to identify the problems currently in the sector; (2) the underlying causes are identified to each of the identified problems; (3) current service provision is mapped and understood; (4) weaknesses in the services are identified through engagement with the local private sector and other stakeholders; (5) and the key factors in the enabling environment are identified; (6) interventions are designed to strengthen service market capacity and strengthen the enabling environment for the core service provision; (7) activities are designed to deliver the interventions.

Figure 5: iDE Intervention Logic



The intervention logic serves as a useful analytical tool to enable the study to identify entry points in the technology market system. In line with the remit and purpose of the study the report will utilize the intervention logic as far as Stage 6. It is anticipated that identified **interventions** will not provide detailed information regarding how to implement these interventions (such activities would be designed in Stage 7), rather the interventions will provide direction towards which areas of the market system can be strengthened to improve technology commercialization. These areas will have a number of **entry points** identified through which development partners can enter the market system. If there is interest in carrying forward activities to implement the interventions, it is anticipated that pilot projects be designed detailing the required activities and the likely impact that these

interventions would have on the system. This is beyond the scope of this study however and would form the inception phase of any pilot project.

6. Key Problems in the Technology Market System

6.1 Key Problems

- **Farmers are not sufficiently aware of technology opportunities**
- **Farmers lack regular or optimal access to technology based services**
- **Adoption of lower quality technologies by farmers**
- **Demand forecasting information can be inaccurate**
- **Insufficient skills throughout sector**
- **Farmers do not receive reliable information and advice**
- **Predominance of demonstrations and subsidy-based models**
- **Farmers' lack of confidence in output markets reduces adoption**
- **Poor access to effective forms of credit**
- **Lack of holistic view of the full market system**
- **Lack of functioning Intellectual Property Rights (IPR) system**

6.1.1 Farmers are not sufficiently aware of technology opportunities

Field engagement revealed that farmers were insufficiently aware of opportunities to access or adopt new technologies. The disproportionately high risks attached to adopting new technologies for small-holder farmers means that a high level of trust and confidence must be developed in order to achieve successful technology adoption. This trust and confidence can be developed through a high level of awareness about the benefits of a particular technology. Farmers must therefore have **access to clear and trustworthy sources of information**. While there is evidence of programs where focused activities have delivered success within a local context, such successes have often been localised and project-driven (often by NGOs). These approaches has not led to systemic market changes which can reach scale, as they have not focused upon the wider information system which supports the market for technology commercialization.

Where technology adoption has been successful it has generally been when the promotional component has been strong. It was found that where technologies are a critical input for production (eg seed, water) these are generally accompanied by a higher level of **information transfer** through promotion and marketing activity. This is evident in the seed sector where on a national scale massive promotion by government has been effective in transferring knowledge of new rice seed varieties. Local input sellers also provide information about different technologies (often regarding the usage and dosage of different chemical technologies) and input companies (such as Lal Teer Seed Ltd, Syngenta,

etc) will disseminate information about different technologies through promotions and marketing of their brand names, especially through dealer and retailer networks.

Evidence of this was found where **the majority of farmers interviewed were aware only of technologies critical to the farm business**. Where the technology was critical (such as seed, feed, or fertilizer) farmers actively sought out information and were generally aware, though where the inputs were non-critical however (such as leaf color charts, or soil testing services) there was lower awareness. Amongst farmers in Bhola it was found that except for rental services of some mechanical technologies such as two-wheeled (2W) power tillers, pumps, sprayers and threshers, the use of other farm technologies was found to be very low. Farmers groups confirmed that the use of modern practices such as soil testing; agricultural technologies such as seeders, transplanters, weeders, and harvesters; chemical and biotechnological technologies such as sex pheromone traps and others is almost negligible amongst local small-holder farmers. The area surveyed characterized an area where **technology promotion is weak** as neither the government nor NGOs did any widespread extension work and there was little evidence of private sector promotional activities. Therefore, when neither the government nor the private sector drives non-critical technologies to the same extent as the critical inputs (and often these are left to NGOs) the **information service is rendered weak.**

The government extension service can be effective and is generally trusted, yet the extension officers are overburdened and farmers can find services difficult to access. Local Sub-assistant Agricultural Officers (SAAOs) are a generally trusted source of information, yet the performance of the information services provided could be improved. SAAOs are often occupied by other government assigned duties (including non agricultural duties such as registering births) and so cannot allocate much time to provide technical services to the farmers. Farmers cited irregular visit frequencies and invitations training programs as key problems with the service. In Char Fasson, farmers stated that as most of the 28 SAAOs are local and are posted around their home village, this position opens the opportunity for perverse incentives.

There are a number of projects and programs undertaken by the government and NGOs to provide agronomic information to farmers, yet **many of these are localized and market-oriented components are insufficiently developed**. Local government undertakes annual agriculture fairs in each upazilla which present a very good opportunity for farmers to access quality information. However, while these fairs offer a venue for market actors reach customers and display the products, they are **not sufficiently coordinated with the needs of the private sector** (with for example certain seeds being promoted after the sowing season - when local retailers are not stocking the product). The lack of effective

promotion has come out very strongly through engagement as a reason that farmers are less aware of technologies, resulting in less use of technologies.

Better results were found to be achieved in areas where **projects incorporated the private sector** into projects from the beginning, and fully integrated them into the development of supply chains. Government-led extension around machine technologies was cited as an example where integrating the ancillary services in the supply chain (such as machinery repair shops and spare parts sourcing) was successful. However, farmers explained that they had many experiences where although projects had provided useful information about modern technologies and agricultural production techniques, they received little benefit once the activities had finished and they did not see them as a source of long term support. NGO and government extension practitioners explained that there is widespread recognition of the role of the private sector in technology transfer, though often the market linkages developed through these projects do not result in functioning supply chains after the project interventions are finished.

6.1.2 Farmers lack regular or optimal access to technology based services

Technology services are **demanded particularly by low-income farmers** as they cannot afford many of the more expensive mechanical technologies. Even when technologies are affordable there is often a preference for technology rental if the technology required is used only infrequently, as this saves on storage and maintenance. **Rental service models were widely observed** in the field, and these were understood to be a more effective means of promoting technologies than through the direct promotion of manufacturers or importers. Farmers explained that they had learned about how they could **gain access to certain technologies through rental service providers**, rather than through manufacturers or retailers looking to sell expensive technologies.

However, field investigation revealed that farmers **do not have regular or optimal access to technology-based services**. A key reason for this was found to be that often **few local service providers (LSPs) are operating proximate** to poorer and more remote farming communities. Engagement with farmers in Bhola revealed that most farmers rent services like land preparation, irrigation and threshing from LSPs, yet due to the **high number of farmers requiring services at peak times** and the low number of LSPs (often 50:1 at peak times such as harvesting and seeding), they often have to wait to get services (usually 2 to 5 days for some mechanical technologies). This poor access to technology services was understood to due to a number of factors. These include that: local services can be unreliable as machines are required to run continuously and become out of order; and, when out of order often LSPs lack the skills to repair machines and have to seek support services elsewhere (such as operating, spare parts, technical knowledge, maintenance and

repair) thereby reducing the viability of a rental business due to the fees, travel and time costs of transporting the machine for repair in larger centers. These factors **drive up the price of rental services and make the businesses less viable in areas where they are most needed**.

Box 1: Technology Rental Services

Access to **technology rental services** is a means of commercializing technologies. Rental services allow larger numbers of farmers to access technologies which can drive production and income increases. A strong rental services market ensures ongoing interaction between technology-owning farmers (such as those with mechanical technologies such as tractors, threshers etc who both utilize the technology for their own production as well as offer services in tilling or threshing) and the farmers purchasing these services. This interaction offers a vehicle for the technology owning farmer to also act as a **commission-based sales agent** working on behalf of one or more technology companies to promote and sell their technologies. This interaction is crucial to the success of the supply chain for technologies as the technology owning farmers offer both ongoing information (from a trusted source) and production services to the farmers. The technology-owning farmer can therefore act as a **scale-agent** for technology commercialization as they offer a means of driving the uptake and successful implementation of new technologies directly with local farmers.

It was observed that where rental services worked well there were **clear drivers for success**. Where services have worked well it was found that the successful areas exhibited strengths in: (1) **finance** as access to finance serves to stimulate the demand side, enabling the farmers to purchase both services and equipment (also currently many technology purchases are linked to remittance income); (2) **technology mobility** as technologies which are mobile and can be easily transported offer better potential for rental than those which are less mobile, enabling greater rental service potential for the technologies employed. It appears therefore that access has been made possible through rental services, and that this access can be strengthened through **improving the performance of the key areas** which drive the interactions between technology-owning and local farmers.

6.1.3 Adoption of lower quality technologies by farmers

The adoption of poor quality technologies disproportionately affects farmers **through decreasing yields and higher prices and leads to farmers distrusting certain technologies**, further reducing the chances of successful transfer. This is a problem primarily with biological and biotechnological technologies such as seeds, but also affects

mechanical technologies either developed domestically or imported from abroad. There has been a recent **focus upon the standards of biological and biotechnological technologies** which have been found to have serious quality issues deriving from local retailers reducing the quality of branded products before selling onto consumers. **Sub-standard mechanical technologies** also create an adverse impact on farmers, as they hinder the adoption of mechanized farm practices. The absence of any quality control mechanism within Bangladesh leads to poor quality advanced machinery such as tractors, power tillers and combines being imported from other foreign countries, primarily China, without any testing or set standards.

Box 2: Seed Quality Issues

Reports in the national media have highlighted the issue of **local retailers packaging low quality seeds under the label of well known brands** of high yielding and hybrid seed varieties in order to charge higher prices[21]. In the absence of any proper monitoring of markets, vendors have been able to reduce the quality of fertilizers and seeds but still benefit from the legitimacy provided through the brand names of large companies, and charge higher prices especially in more remote areas. Farmers confirmed this as a key problem, with a number of stories of poor yields attributed to the quality of inputs. This included for example a bitter gourd seed variety, Tia F1, produced by Lal Teer which showed less than expected results last year, investigation subsequently revealed that **district level seed distributors were mixing impurities in the packets**. Although farmers' associations can provide assistance through offering a means of triangulating agronomic information and often conduct their own viability trials of a range of farm technologies, many low-income farmers lack a mechanism by which dishonest retailers can be held to account.

Engagement with ARIs and farmers revealed a number of reasons why **many domestically developed and imported technologies have not performed well in the field**. Farmers were generally very cautious in adopting new technologies, with most adopting only after first seeing demonstrable success from other farmers. Many farmers claimed that may technologies developed did not pass the test from first users, and therefore they were not persuaded to adopt these at the field level. These issues also affect the quality of imported technologies into Bangladesh, particularly **imported agricultural machinery** which is certified only by the country of origin. As a result, many low graded mechanical technologies (such as engines) imported at cheap rates have failed to perform well in the

[21] See: *Low quality seeds flood Gaibandha markets*, Daily Star, Sunday, December 4, 2011, http://www.thedailystar.net/newDesign/news-details.php?nid=212771

field. Regarding perishable goods such as seeds, quality control presents a further issue. When companies import or produce more seeds than necessary often the seed quality degenerates due to sub-optimal storage facilities, and yet these seeds are still repackaged and sold in the market in subsequent years. Examples such as these damage the trust amongst farmers regarding such technologies, an issue which is compounded by the absence of any **body or committee to test and authorize either imported or locally manufactured technologies**.

6.1.4 Demand forecasting information can be inaccurate

Engagement with companies revealed that **demand forecasting is often inaccurate in Bangladesh,** hindering the development of more efficient supply chains and dis-incentivizing companies from investing in areas where markets are weaker (and often where they can most benefit poor and marginalized farmers). Demand forecasting is a **key element of any business projection**, information regarding the demand for products and services enables companies to promote their products, expand into new markets, and launch new technologies. Quality information regarding the size of the market and the likely take up of products and services, enables companies to take calculated risks and identify potential returns on investment, prime concerns for many businesses requiring large capital investments, such as for example importers of biotechnological technologies (such as vaccines) with which sales are time-limited.

A number of reasons were highlighted to explain inaccurate demand forecasting in Bangladesh. These include: a **lack of capacity in the private sector to effectively gather information from farmers**, as many companies do not have any scientific mechanism or dedicated experts to forecast demand effectively. A representative of a major seed company explained that projections for the coming year's production requirements are entirely dependent upon simple calculations drawing upon information from previous sales volumes. This information is often compromised by the perverse incentives of seed retailers who do not present true figures. As such, the seed company often fails to capture an accurate picture of what farmers want to produce or what seeds they want to sow on their land. A major poultry vaccine producer explained that the business model for vaccine products involves imports for a number of vaccines[22] and the quantity to be imported is decided through supply side information.[23] While the data allows the company to roughly calculate how much they should import based upon how many chickens are produced every year in comparison to their present market share, this nevertheless **fails to provide**

[22] Particularly for poultry diseases like Newcastele disease, bronchitis, endrop syndrome etc
[23] The company uses data from Grand Parent Stock (GP) farms, of which there are six in Bangladesh Paragon (Aftab, Nourish, Kazi, MM Azad and Rafid) and Parent Stock (PS), or hatcheries, of which there are around 150 in Bangladesh, to forecast how much they should import and stock.

demand side information. Such information could provide important information regarding end-users' constraints in purchasing the products.

Forecasting demand across the country is further hampered due to **inconsistent access to GoB data at national and local (district) levels**. Private companies explained that every district level agricultural offices should have detailed information on how much land area which crop varieties were sown on a regular basis. When these public agencies provide this data then demand forecasts can become more efficient, however as they do not provide this data consistently this makes the service too unreliable for businesses to exploit. Some companies claimed that they **do not know how to engage with the government effectively** and therefore mostly depend upon their own estimates and data provided by their dealers. One vaccine producer explained that the organization had never had the opportunity to work closely with the GoB (or NGOs) and that they had not attempted to work with the GoB through MoUs. Many **businesses are disincentivized to enter new markets or launch new products without accurate demand forecasts** to underpin investments. As it can take around two years to launch a new product and therefore the company has to forecast the future market well. It was explained that the business strategy for the major poultry vaccine producer was to spend very less on promoting products and expanding their market in favour of going to areas where there is already an existing market.

6.1.5 Insufficient skills throughout sector

Skills are crucial for ensuring technologies can successfully adopted through the commercialization system. Particular skills are required in the areas of business-planning, marketing, promotions, and risk management to ensure that the system performs more efficiently. **Insufficient skills capacity is a problem** identified by stakeholders engaged throughout the sector. There are **capacity issues in the private sector**, notably in understanding how to form partnerships with the public sector and in demand forecasting (see 5.1.4 above). Many private companies engaged with did not know how to engage with the government sector effectively, through for example MoUs or joint-working arrangements. It was highlighted during stakeholder engagement that there are **spatial disparities in capacities**, with generally more skills available in urban areas (primarily Dhaka) for both production-side areas such as manufacturing and demand side areas such as business and management skills, than are found in rural areas.

In the government sector it was clear **that commercialization approaches have not been fully integrated into government extension programming**. After a product is developed (in most cases, this is a three or four year process), ARIs provide training to DAE officials to underpin its transfer, this training has not led to commercialization models

being embedded into extension service programming and while private sector players are being included, generally this is in an implementation capacity rather than being central to program design. It is clear that both government and the NGO sector requires development to **strengthen a market systems thinking approach** (ie how to bring the product to consumers) rather than adopting a technocratic approach which focuses on new products without the business systems required to take them to market. There was identified in **research programs focusing on demonstration and neglecting effective supply chain development.** This leads to a poor uptake of technically sound through not commercially viable technologies and lends support to the 'Valley of Death' scenario outlined above (see: 1.2), where research and commercial investment tails off before robust local supply chains can be developed to support technology commercialization.

6.1.6 Farmers do not receive reliable information and advice

Reliable access to quality information is key to operating a successful farm business. Farmers generally rely upon local retailers for **information** yet instances of asymmetrical information lead to **farmers often receiving unreliable advice** from retailers. This can take the form of retailers prioritizing certain technologies they want to sell due to incentives driven by commissions from supplying companies; or, as discussed above (see: 5.1.3), can involve retailers mixing impurities with branded inputs before selling onto farmers. This causes farmers to often pay **higher prices for lesser quality inputs**, and leads to hesitancy on the part of the farmers to adopt better quality inputs and encourages seed retention (for example they often choose to retain seeds to reduce the amount they have to purchase from retailers). This is not limited to seeds, with negative experiences reported by farmers when purchasing chemical technologies. In Rangpur farmers cited issues of mistrust regarding pesticides in local markets, with retailers repeatedly applying ineffective pesticides on the advice of retailers.

Despite often holding reservations about the quality of information received from retailers, **farmers continue to consult for advice mostly from local retailers**. These retailers are not always trusted by farmers, they present an ever-present source of information as their customer-oriented model ensures they are both responsive and generally located proximate to their customer base. **Government provided information sources (extension officers) are generally trusted by farmers**, yet poor access to these sources was cited as a key constraint to exploiting this service. Farmers engaged in Bhola confirmed that service provision by SAAOs is trusted but is not as accessible as services provided by NGOs and local retailers, which they also interact with at the local level. Farmers revealed a strong appetite to be connected to **new channels of information** such as other retailers, associations, lead farmers, and direct input companies. These alternative

channels were reported to be desirable as they offer the opportunity for information to be triangulated between different sources; yet these often also provide unsustainable or irregular services (for example they are project dependent or the staff are overburdened). Indeed, there are certain specialized areas such as mechanical technologies where the farmers cannot always access quality support; due largely to a **lack of specialized technical skills in the field level**.

6.1.7 Predominance of demonstrations and subsidy-based models

The continued presence of **demonstration and subsidy-driven technology transfer approaches** encourages non-market incentives. These approaches, undertaken by both NGOs and government, present issues in that often subsidies can be applied ineffectively, for example supporting areas which are already experiencing growth[24], and that such models often fail to strengthen ancillary services in the market system, leading to weak supply chains which are not sustained beyond the duration of the project. Such initiatives often fail to consider the full market system even when following 'market-led' approaches, and **do not address the issue of poor adoption of agricultural technologies** by farmers. An example of this is where government continues to subsidize certain technologies even when the markets have already taken off commercially, an example that was highlighted in the four-wheeled tractor (4WT) market where 25% subsidies continue despite growth in the sector of 10%[25].

Farmers that had participated in a **subsidy-driven agricultural machinery** transfer project revealed that although they were interested in purchasing machines for their land, there were **a number of disincentives**. These included that: the machines were not available in local markets as dealers only sell machines that have established demand; they were unsure about how to overcome technical issues such as how to operate or maintain those machines effectively, and where they could access support services; they feared a high cost of repair should the machine break down as local mechanics and workshops would not have the skills and spare parts to repair quickly and cost-effectively; and, the dealers would not provide warranty, after sales services, or instalment payment plans; and, the GoB or NGO loans available were not flexible enough to overcome the risk of purchasing a machine.

6.1.8 Farmers' lack of confidence in output markets reduces adoption

The **security of the output market** is a key factor determining the uptake of technologies by farmers. Secure output markets increases farmers' investment in new technologies as if

[24] 2WT and 4WT have a nearly 10% growth rate, yet these are being subsidized
[25] Source: iDE Study on Farm Mechanization (forthcoming).

farmers have increased security they can plan more effectively for the upcoming crop. Where there is a large market and farmers need to produce quickly it is more likely that they will seek access to technologies to drive production and enable them to meet this demand. Therefore if well functioning output markets reduce farmers' risk-averseness towards investment decision-making in technologies, then **poor confidence in output markets reduces investment in innovations and the adoption of new technologies**. Vegetable farmers interviewed explained that if they believe that the demand for vegetables is for a certain amount at a certain price, they will invest in these crops in order to meet demand, often purchasing technologies (such as hybrid seeds) or technology services (such as planters) in order to meet this demand. When they feel less security for the demand of their products, they are less inclined to invest.

6.1.9 Poor access to effective forms of credit

Field engagement revealed that **poor access to effective forms of credit as one of the key constraints to farmers investing in new technologies**. This was found to be particularly evident in areas characterised by weak markets. Although many NGOs are providing microcredit services, the **lack of flexible credit services** was identified as one of the farmers' largest constraints. Farmers explained that the choices available for financing new technology purchases were not attractive enough: NGO loans are mostly small loans which are insufficient to purchase most agro-machineries and involve a prohibitively high interest rate and instalment frequency; and taking loans from government operated Agricultural Banks (such as Krishi Bank) involves a lengthy process, and excessive paper-works. Input retailers were found to offer flexible payment conditions inconsistently and farmers complained that they **lacked the required social capital** (such as family connections) required to access credit facilities which could enable them to make viable purchases (particularly when purchasing machines).

The private sector can drive better results in technology adoption through flexible financing models. Evidence in tractor sales, currently experiencing a growth rate of 10%, can be seen to be partly attributable to flexible financing models. Engagement with machine technology companies and local farmers found that the companies are aligning their financing models with market demand. These companies were found to be **making agreements with their customers to take payment in instalments**, and provided further support to teach the machine owner how to drive (an instructor) and also offering maintenance and repair services. In this model, since the company's money was at stake, the company provided the customer with necessary support services. However, with food crops it was highlighted through engagement that **credit tends to work only for high value crops** in a given locality. Generally where returns are lower, as is often the case with

crops grown by generally risk-averse low-income farmers, the structure of loans (servicing frequency, interest rate etc) is often incompatible or not viable. Therefore while the private sector can help in some areas, more innovative financing models to support technology adoption in support of low-income farmers' agricultural businesses were not found to be offered currently by financial service providers.

6.1.10 Lack of holistic view of the full market system

As commercialization is a relatively recent approach adopted by development agencies compared to research and transfer (see discussion in 2.3 above), there varied approaches through which the commercialization approach is being implemented in Bangladesh. Evidence from the field shows that there are many government and NGO supported projects on technology transfer which now seek to implement a 'market-led' approach to technology transfer, and often work with private sector partners. Yet many of these approaches either adopt piecemeal strategies which **fail to consider a holistic view of the full market system**; or when projects do show success based upon a full analysis of the market system, these **projects are necessarily time limited** due to funding constraints. Beyond the cycle of project-based interventions, there was no evidence found of an ongoing system which could serve to bring further promising technologies into the market. Engagement with stakeholders did not reveal any body or organization that could continuously promote and coordinate the technology market system, to support the continuous commercialization of new technologies.

6.1.11 Lack of functioning Intellectual Property Rights (IPR) system

As discussed above (see 1.2) **IPR plays a key role in providing incentives for innovation amongst entrepreneurs and technology manufacturers**. As has been noted by the WB and others, while Bangladesh has a number of legislative mechanisms to support IPR[26]; the reality is that where these powers may be invoked in relation to high value technologies these are largely unenforceable for low-cost technologies manufactured and sold locally. While this may stimulate the production of low-tech, locally produced machinery this also acts as **disincentive for larger industrial firms to produce at scale**, and relies upon 'organic' demand rather than a pro-market demand creation system. Local manufacturers and workshops have very low production rates, are **unspecialized** as they cater for products which are highly seasonal in terms of utility, and usually do not provide after sales service.

[26] Many of which date back to colonial times such as the Patents and Designs Act (1911), which provides for the registration of designs, the Trademarks Act (1940) where it is a criminal offense to counterfeit trademarks, and is a signatory of the more recent Trade-Related Aspects of Intellectual Property Rights (TRIPS) (1994).

Engagement with market actors revealed that it was **widely felt that counterfeiting and piracy of technologies was on the rise in Bangladesh**. The absence of IPR was highlighted by representatives of companies producing new technologies as an important issue with ensuring security regarding new innovations a top priority. The context of weak **intellectual property rights** in Bangladesh, combined with high levels of counterfeiting, contributes to the low numbers of mechanical technologies which make it to commercialization. This weak regulatory environment impacts upon exports from Bangladesh as such exports are hampered by the lack of international certification from bodies such as the International Seed Testing Association (ISTA). The chemical and mechanical sectors are heavily shaped by government policies and subsidy schemes. The GoB currently has a **subsidy policy** on fertilizer and continues to set fertilizer prices. **Import tariffs** exist for the certain mechanical goods – and low numbers of mechanical technologies making it to commercialization.

7. Service Analysis

7.1 Identified Services

1. Farm Information Services
2. Promotional Services
3. Financial Services
4. Market Information Services
5. Coordination Services

The intervention logic methodology (see 5.2) requires that in order to identify which services can address the various problems identified in Chapter 5, it is first important to analyze and identify the underlying causes of these problems. This analysis is articulated in the Intervention Logic Analysis Table (see Appendix 4) which highlights these underlying causes and the relevant services which exists in the market system. Based upon this analysis[27] it is believed that there are **broadly six problems which can be effectively addressed** to strengthen the system and five which it is not possible or worthwhile to address at this time[28]. The six problems which it is believed can be addressed comprise: farmers awareness of technologies (covered in 5.1.1); demand forecasting (5.1.4); the reliability of information (5.1.6); the continued presence of subsidy-based models (5.1.7); access to credit (5.1.9); and, the lack of a holistic view of the full market system (5.1.10). There are a number of **services in the market system which could address the underlying causes of the problems highlighted**. Most of the identified services exist in the system in one form or another. It is important to strengthen these services.

7.1.1 Farm Information services

The **quality and reliability of information accessed by farmers** have been revealed to be a major constraint in the adoption of potentially useful agricultural technologies. It has been seen that farmers are often highly risk-averse when deciding whether to adopt new technologies and require a high level of certainty regarding the performance of the technology, or guarantees to mitigate poor performance. Information is particularly weak regarding non-critical technologies which can have a high impact upon yields, and farmers'

[27] This is the methodology that has been applied to conduct a service analysis
[28] Due to the limitations and scope of the study, the analysis will focus upon problems that it is believed can be addressed through actionable interventions. The study will not seek to address particular problems if: interventions to address them may have to be too sector specific, that results would be too long-term to achieve measurable impacts, and that some issues may be partly addressed through other interventions (see Appendix 4: Intervention Logic Analysis for more details).

incomes. Although **a number of sources of information exist in the market system**, these have been often found to be compromised in practice.

Local retailers, that often present the most accessible source of information, have been found to sell inputs predicated upon commissions received from input supplying companies rather than based primarily on consumer need. Also, many examples have been seen of retailers operating dishonestly through manipulating the quality of inputs (particularly biotechnological technologies such as seeds and fertilizers) and selling false products under established brand names. There are many **lead farmers and farmers' associations** operating in the field. While many of these offer a very good means of support to farmers seeking market and technology specific information, they are often rooted in local 'social' relationships rather than operating as an institutionalized service in the system. This can lead to issues of accessibility and information quality as certain groups may be marginalized (particularly women) and that such groups often do not possess expert knowledge of new and emerging technologies. It has been seen that **Government SAAOs**, while generally useful in supporting farmers, also suffer from over-burdening and farmers cannot always access their services. Given this context it is therefore suggested that the information service form a key priority for any intervention seeking to strengthen the technology market system in Bangladesh.

7.1.2 Promotional Services

Promotional services exist in the market system, yet these are generally not driven by the requirements of farmers or always informed by expert knowledge. Farmers are **not sufficiently aware of technologies** and the underlying causes of this lack of awareness have been found in irregular access to extension services (either provided by government or NGOs), the poor quality of extension services implemented, and a lack of investment by technology manufacturers in promoting products amongst low-income farmers. The private sector is not integrated into the design and scheduling of key market development events, such as agricultural exhibitions, or extension activities, such as product demonstrations. Therefore given that the importance of effective promotion in communicating information about new technologies and how to access them, the promotional service is seen as a key area for intervention in the market system.

7.1.3 Financial Services

Poor access to effective forms of credit was found to be a problem raised by farmers and other market actors during fieldwork. There were a number of reasons for the poor access they were experiencing, including the lack of flexible credit facilities on offer by the private sector, particularly when consumers are purchasing large capital technology investments

such as agricultural machines (unless soft loans are available through connections). Government and NGO credit facilities were also found to be often too inflexible for purchases of certain technologies, with government loans not always easily manageable due to the administrative burden and high interest rates; and NGOs often allocating too small amounts with high interest rates and instalment frequencies. Clearly a **range of service providers exist in the market** to provide financial services, though there is a **lack of commercial providers**, with the majority operating in the government or NGO sectors, and offer options not flexible enough to accommodate the needs of farmers wishing to make certain technology purchases. Therefore, despite the amount of activity in the financial services sector in Bangladesh, particular amongst MFIs, the service is nevertheless rendered weak due to the lack of flexibility to accommodate new technologies as they arise.

7.1.4 Market Information Services

Inaccurate **demand forecasting** has been seen to be a key issue highlighted above. The underlying causes of this have been found to lie in a lack of any scientific mechanism or dedicated expertise to forecast demand in a range of agricultural sectors efficiently, acting as a key constraint for businesses growth. Where sources of information do exist, for example in the form of the District level agricultural offices, **access to these sources can often be inconsistent or the data provided unreliable**. The information service can therefore be understood to be underperforming due to a lack of capacity in the private sector to accurately forecast demand, inconsistent access to GoB data, and a lack of focus on ensuring that information generated is driven by the requirements of farmers in the field. Therefore, given the central importance of information revealed through field investigation, the information service can be seen to be a key area for intervention to support the sector.

7.1.5 Coordination Services

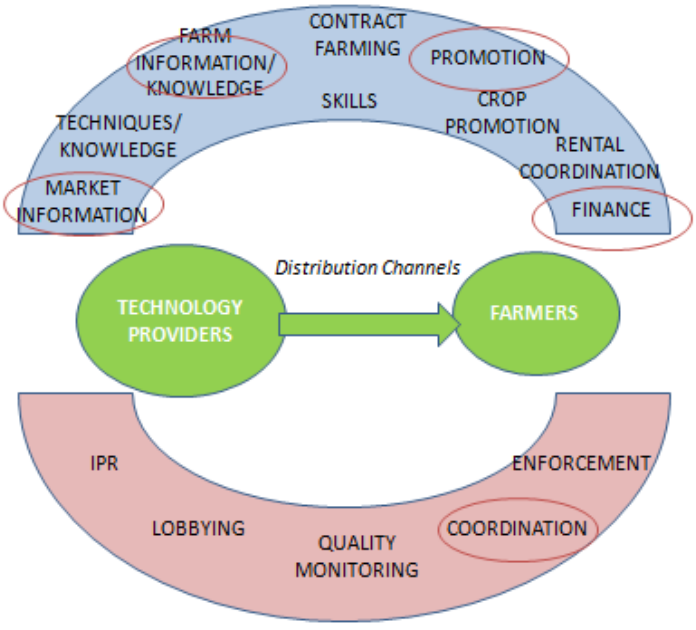
The **predominance of demonstrations and subsidy models** in many technology transfer projects has been highlighted as a problem through fieldwork. This has been seen to be due to the **failure of many involved in the system to take a holistic view of the technology market system**. This leads to that projects continuing to operate technology transfer models which fail to strengthen ancillary services in the market system, leading to poor sustainability once projects are completed. Also, it is clear that farmers' voices are not prominent enough in research and development leading to extension services not achieving large-scale adoption through demonstrations, as farmers often remains reluctant to purchase many technologies. The underlying causes of this reside in a general lack of expertise in commercialization and business thinking amongst the architects of many projects and public extension services. It is clear that information and expertise needs to

be transferred throughout the system to improve sector performance, and the private sector integrated early into new technology transfer activities. A **coordination service** provider was not found to exist currently in the market, and an organization, institution, or agency could be found to fill this role, this would serve to ensure public and private actors are aligned in their approach to technology commercialization, ensure best practices informs current implementation, and act as a champion for the commercialization approach.

7.2 The Technology Market System

The analysis above now enables the study to conceptualize the market system for technology commercialization and adoption in Bangladesh. In this model, (see figure 8) the **core function** involves the movement of technologies from commercial actors to farmers as unsubsidized purchases of products and services. The private sector is clearly the major player in the system though Bangladesh features a large number of NGOs operating in the manner of private businesses. **Supply** in this case can be directly related to the **demand** of the farmers for the products and services on offer, or to the priorities and objectives of NGOs operating in the system.

Figure 6: The Technology Market System in Bangladesh



The **supporting functions** for the technology commercialization system comprise a number of informational functions at the farm level (farm information and knowledge, crop promotion), and at the wider market level (market information and promotion). Other supporting functions found to play an important role in moving technologies through the system include the skills base in the sector, rental coordination, commercialization techniques and knowledge, and access to finance in the system. The **rules** guiding behaviors in the technology market system can be seen to be shaped by weak IPR and regulatory environment (quality monitoring), and changes in government policy (though lobbying). A number of **regulations** exist in Bangladesh to improve the quality of technologies, but these are often ineffective due to the difficulties of enforcing

these regulations effectively and equitably throughout a large unregulated informal sector. Analysis has shown that the general picture of the movement to foster the uptake of technologies remains **uncoordinated.**

8. Entry Point Interventions

8.1 Overview of Interventions

1. Involvement of private sector in the design of Upazilla agriculture exhibitions
2. Establishment of an Technology Needs Assessment Center
3. Introduction of demand forecasting system
4. Introduction of agri-clinics
5. Strengthening of technology financial products

In accordance with the remit of the study project, **five key interventions** have been identified as the most relevant entry points for a pilot project to strengthen technology commercialization in Bangladesh. It is anticipated that these interventions would result in quick wins that would help to develop a system where better market system analysis informs the promotion of technologies by the private sector and the government. This will help farmers to access agricultural technologies and increase their incomes.

8.1.1 Involvement of private sector in the design of Upazilla agriculture exhibitions

It is clear from the analysis above that **promotion plays a key role in the success of technology commercialization**. While the private sector is promoting various technologies on their own, the upazilla agriculture fairs are one of the means for this promotion. However, this fair is organized without much participation of the private sector, thus the involvement of the private sector should make the fairs more effective and support the promotion of technologies.

This could be achieved initially through developing partnerships between **private sector associations and government upazilla offices**. Agreements reached would result in better participation from the private sector from the design phase, enabling various technologies to be targeted each year for promotion based upon a demand-driven model. The design of the fair will **include all the ancillary services around the technology** (the full market system) and will provide a 'one stop shop' regarding the purchase. use, and maintenance of the given technology.

In implementation around 10 locations in different areas of the country would be taken as pilot upazillas. Relevant national, regional, and local associations, such as the **Bangladesh Seed Association and the Bangladesh Agricultural Machinery Merchant Association (BAMMA),** will be offered roles as partners in the pilot as required. The learning from the pilots including the potential impact at all levels of the value chain will be showcased to the

national government. Demonstrating success through increased technology adoption would enable a case to me made to government to **re-visit the current system of organizing agriculture fairs** and seek to scale-up change throughout the country. This would result in strengthened **promotional services.**

8.1.2 Establishment of an Technology Needs Assessment Center

The need for continuous assessment of demand for low-cost technologies has been highlighted as a key issue (see: 5.1.4 above). It is believed that the establishment of a center to analyze technology needs in Bangladesh would strengthen the commercialization system. Such a **center would function by continuously analyzing various agricultural sectors and acting as a technology hub to attract suitable technologies.** The center would proactively scan the market on a regular basis and match the demand and supply side, to increase farmer access to technologies. It would analyze the systems around certain promising technologies and propose and implement interventions in partnership with the actors in the value chain.

Organizations like the **Rural Development Academy (RDA)** who are working on technology transfer would benefit from the establishment of the center. Such organizations would have an advantage, as it would provide them with an **evidence base to lobby the government** and steer the various programs of the government to follow a more market oriented approach. Initially, this could be **piloted with a few technologies** and if the pilots prove successful, then RDA would establish itself as a center of excellence in identifying and commercializing the technologies in the country. Market-driven and customer-oriented, the center's activities could be supported by the Government and the private sector, depending upon the analysis undertaken to increase technology sales. This would strengthen **coordination and lobbying services.**

8.1.3 Introduction of demand forecasting system

Findings suggest that the system of demand forecasting is not scientific, leading to inaccuracies in information which is crucial for effective business planning. Therefore, **a demand forecasting system needs to be created in Bangladesh**. The system will take in account the method of collecting information and offer a database for such a system. The system would be market driven, with an envisaged fee for service commercial model.

It is envisaged that to implement this intervention, the necessary market actors for both initial sources of demand and the necessary expertise are available. The **Bangladesh Seed Association and the Bangladesh Agricultural Machinery Merchant Association (BAMMA)** would be the most likely initial partners in this venture. These associations have individual members who would present a potential source of demand for demand

forecasting services. Expertise to develop the system is available in the form of private organizations already successfully providing market information services to paying clients, such as AC Neilson whose interest could be sought. As the venture would be private sector driven, market viability. Initial traction for such a system could be ascertained through conducting a feasibility study in partnership with the market actors. Such a continuous demand forecasting system would enable to companies to plan better and not to over-produce. This would enhance the quality and accessibility of market information services.

8.1.4 Introduction of agri-clinics

Clearly the most regular of contact for many farmers in the field are the product retailers. Yet while much of the information retailers provide is good, farmers **need to triangulate the information** in order to test its quality. The introduction of **agri-clinics** would provide an impartial source of information which farmers could consult as required to give them confidence in what they are hearing from retailers and other market actors. In addition, the agri-clinic 'doctors' could also provide other information on new technologies to the farmers.

There are various models for how the agri-clinics could operate. Different NGOs do provide reliable information to the farmers in various projects, which farmers feel is impartial. Intercooperation has moved beyond this to establish a Rural Advisory Services model, and have seen that such services can be a **fee paying model**. The agri-clinics envisaged in this intervention, could initially take the form of various service providers coming together and providing necessary services to the farmers. This could develop into a fee-based service, where the service provider is sitting either in retail shops or other locations that farmers frequent. The clinics would operate for a regular time each day. Once the model proves successful in the pilot areas, certain institutes could provide training packages for such service and provide accreditation for the courses. Projects would need to promote the courses, accreditation and then the service providers for some time, before it takes off.

This would be **piloted in a few unions**. A search would be undertaken for people (lead farmers, people associated with commercial farms etc) that would be interested to provide such services. The extra money that they earn would be an incentive for them to continue such service. These providers would not be an agent with any company (like the doctors). The retailers would appreciate such services, as ultimately a mechanism to test the quality of their advice would serve to strengthen honest retailers through enhanced reputation at the expense of those seeking to take advantage of farmers. They could also start selling other technologies and inputs, as advised by such providers. This would put in place strengthened farm information/knowledge services.

8.1.5 Introduction of technology financial product

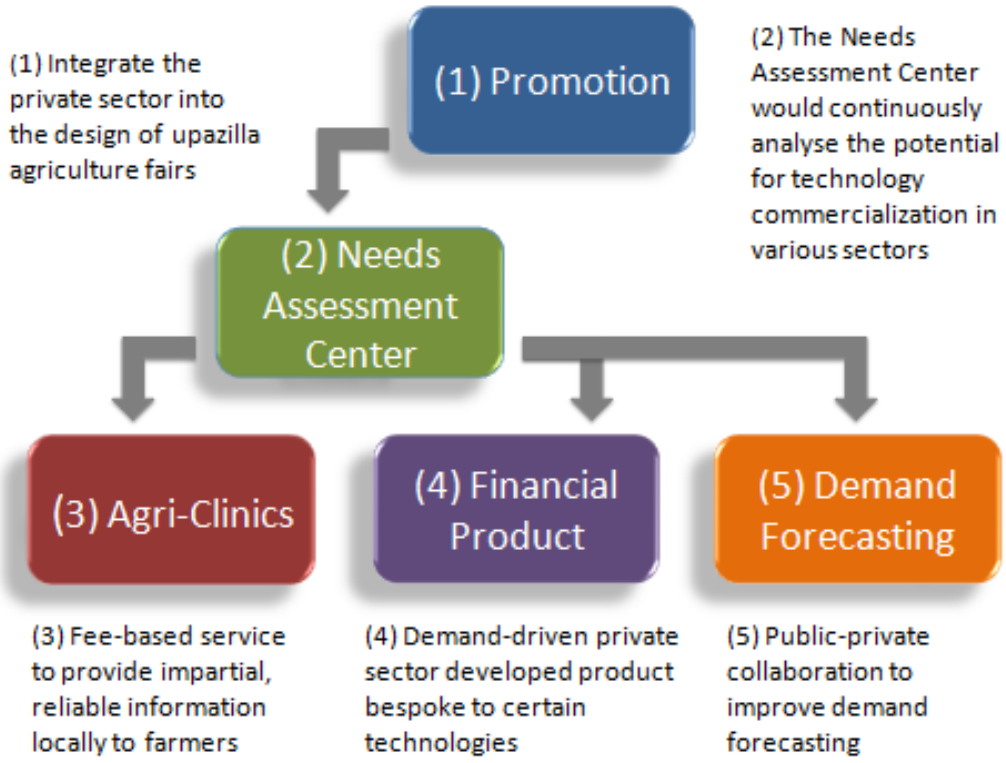
It is clear that the financial service currently operating in **the market is not providing the sufficient flexibility to enable technology adoption in many cases**. There have been examples of success however, notably in financial products designed for mechanical technologies – such as those supporting the recent growth in tractor sales in Bangladesh. Therefore innovation in financial product development exists, yet these **successes appear largely ad-hoc** rather than deriving from any systemic strengths. As technology development is dynamic, there is a clear need to ensure that the development of supporting financial products is equally dynamic, in order to push new technologies to scale. There is no service to continuously search for whether technologies require what financial products to move them in the system. Such **coordination could ensure that financial service providers are continuously engaged in the development of new and innovative financial products**, matching which products could fit which technologies, and supporting in developing and promoting the products. It is recommended that such a coordination service for innovative financial products be initially piloted, and once proven to be successful, the service could reach scale through existing platforms and institutions. The institutions would look in the future to a close collaboration with RDA in order to continuously learn what RDA is analyzing and prepare appropriate financial products accordingly. This would strengthen technology financing service provision.

8.2 Sequencing of Interventions

Since, this study is part of a potential pilot project, it is important that the interventions identified above are situated within a **logical sequence for implementation**. Such sequencing is important, as some interventions may provide impacts more quickly than others, and some may be dependent upon other interventions in order to achieve success in the field. The general order for the five interventions outlined are: **first, promotion** should be undertaken, as integrating the private sector into agricultural field exhibitions and other NGO and public sector led extension interventions offers the potential for a 'quick win' in generating early impacts. **Second, the Needs Assessment Center** would serve to capitalize upon the promotions driven by the public-private collaboration to institutionalize the progress made. The establishment of the Needs Assessment Center would provide direction and coordination to further interventions and underpin the success of the ongoing interventions. **Following this the agri-clinics, financial product development, and demand forecasting services** would have a point of contact which can provide the support required to ensure these interventions are successful. The Needs Assessment Center could also identify other interventions necessary in the different technologies they analyze. Hence, interventions 3-5 are some areas that have been

identified, but more would likely be identified by a well functioning Center. This sequencing is articulated in the figure below.

Figure 7: Sequencing of Interventions.



9. Conclusions

The adoption of low-cost agricultural technologies bought unsubsidized by small-holder farmers offers a means of **sustainably alleviating poverty and increasing food security** in Bangladesh. Yet Bangladesh is not currently maximizing its potential to commercialize promising designs and new ideas, leading to many technologies failing to enter the market and reach customers effectively. The challenge for development organizations is to intervene to **strengthen the market system and incentivize market actors** to provide or extend the services required by small-holder farmers to improve their competitiveness. This study has analyzed the current market system for low-cost technologies and found that there are clear areas where intervention can achieve this result. The interventions proposed here present an opportunity to increase the amount and quality of technologies adopted by farmers through a **commercialization approach**. Small-holders can be integrated into well functioning markets and enabled to develop their livelihoods and reach their potential.

However, identifying the solutions alone will be insufficient to achieve lasting change. Rather, interventions must be actively designed and developed in collaboration with the market actors who will drive the system forward. Organizations, individuals and institutions must be persuaded and incentivized to embrace a holistic market-led approach. In some cases the status quo must be challenged, and vested interests overcome. The challenges in Bangladesh remain vast. Yet the country presents fertile ground for this approach. Development organizations must show initiative, creativity and leadership to demonstrate success and build momentum going forward. iDE looks forward to collaborating with SDC in this important work.

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Appendices

Appendix 1: Public Sector Agencies in Agriculture

Agricultural Research Institutes (ARIs)

- **Bangladesh Agricultural Research Institute (BARI).** BARI has more than 600 researchers, seven crop research centres, 14 research divisions[29], six regional research stations, 28 substations and a number of trial sites spread over various agro-ecological zones of the country. BARI also has a Plant Genetic Resources Centre (PGRC), which maintains germplasm collections for research and conservation purposes, and has recently established a Biotechnology Division. BARI has 7 crop research centres, 4 of which are at the central research station at Joydebpur. These include Tuber Crops Research Centre (TCRC), Plant Genetic Resource Centre (PGRC), Oilseed Research Centre (ORC), and Horticulture Research Centre (HRC). The Wheat Research Centre (WRC) is situated at Nashipur, Dinajpur, while the Pulses Research Centre is located at Ishurdi, Pabna and Spices Research Centre (SRC) at Shibgonj, Bogra. Apart from these, the Institute Conducts technology validation trials and farmer's field trials through its On-farm Research Division (OFRD) in 9 Farming System Research (FSR) sites and 72 Multi-location Testing (MLT) sites spread over the country. Since 1961 it has been disseminating technologies both in commodity and non-commodity forms for all the non-notified crop varieties.
- **Bangladesh Rice Research Institute (BRRI).** BRRI conducts research on all aspects of rice and has nine regional stations. It maintains a Biotechnology Division with eight researchers and a Genetic Resources and Seed Division with ten researchers. BRRI has so far released 52 varieties including hybrid varieties. Some of the varieties have been widely adopted throughout the country and contributed heavily in achieving self sufficiency in rice production.
- **Bangladesh Institute of Nuclear Agriculture (BINA).** BINA was established as a small radio-tracer laboratory in 1961, with a mandate to conduct research on rice, pulses, oilseeds, jute, cotton and tomato, applying nuclear/radiation techniques. It has five substations, employs about 80 researchers and maintains a Plant Breeding

[29] Plant Pathology Division, Soil Science Division, Farm Division, Entomology Division, Plant Breeding Division, Agronomy Division, On-Farm Research Division, Agricultural Economics Division, Farm Machinery and Post Harvest Process Engineering Division, Planning & Evaluation Division, Irrigation and Water Management Division, Seed Technology Division, Postharvest Technology Division, Bio-Technology Division, Vertebrate Pest Management Division, Repair & Maintenance Division

Division, including a tissue culture laboratory. So far, BINA has released seven rice varieties. BINA dhan 7 is a salt-tolerant variety. BINA has developed 43 released varieties of seed and bio-fertilizer along with 25 agronomic technologies.

- **Soil Resources Development Institute (SRDI).** SRDI is responsible for overall strategic guidance of the use of soil resources in Bangladesh. So far it has produced guiding documents on soil resources up to Upazilla level. Moreover, it has been providing services like soil testing from its central lab in Dhaka.
- **Bangladesh Jute Research Institute (BJRI).** BJRI has 11 divisions[30] and research stations working with an aim *'to promote agriculture, technological and economic research on jute and allied fibers and their manufactures and dissemination of results thereof'*. So far it has developed 17 varieties of jute. It has also been providing extension services on Jute through various programs.
- **Bangladesh Sugarcane Research Institute (BSRI)**. Two basic functions are performed by this institute: (1) development of sugarcane variety as well as improved production technology; and, (2) dissemination of varieties and technologies to the farming community. The research wing consists of eight research divisions, one quarantine station and two regional stations, whereas the institute's Technology Transfer (TT) wing consists of two major divisions, six substations and three sections.
- **Bangladesh Fisheries Research Institute (BFRI).** BFRI is responsible for fisheries research and extension. It has 4 station and 8 sub-stations across the country. It has developed 11 technologies on fish breeding and seed production, 12 technologies on fish culture, 6 on integrated farming, management and policy formulation, and 6 on bio-technological aspect.
- **Bangladesh Livestock Research Institute (BLRI).** BLRI has developed 59 technologies on various management issues along with production system on livestock. It has 8 research divisions.
- **Bangladesh Forest Research Institute (BFRI).** BFRI has 11 research divisions under forest management branch, 6 under forest products branch and 2 common services divisions.
- **Bangladesh Tea Research Institute (BTRI).** BTRI conducts research to increase yields and quality of tea by developing improved production technologies and high yielding tea clones. The Institute has nine divisions in its headquarters and three sub-stations (Kaliti, Moulvibazar, Sylhet town and Fatikchheri, Chittagong).

[30] Agronomy Division Breeding Division Fiber Quality Improvement Division Farm Managment Unit Genetic Resources & Seed Division Jute Farming System Division, Pest Management Division, Mechanical Processing Division, Textile Physics Division, Pilot Plant & Processing Division and Chemistry Division.

- **Bangladesh Sericulture Research and Training Institute (BSRTI).** BSRTI has an aim to develop appropriate tropical technologies to increase the silk production. So far, it has developed 6 released varieties of silk worm and 4 are waiting to be released. It has a germplasm bank.

ARIs role in Agricultural Technology Sectors

Agricultural Research Institute (ARI)	Biological	Mechanical	Chemical	Agronomic	Biotechnological	Informational
Bangladesh Agricultural Research Institute (BARI)	✓	✓		✓	✓	✓
Bangladesh Rice Research Institute (BRRI)	✓	✓		✓	✓	✓
Bangladesh Jute Research Institute (BJRI)	✓			✓	✓	✓
Bangladesh Institute of Nuclear Agriculture (BINA)	✓			✓	✓	✓
Bangladesh Sugarcane Research Institute (BSRI)			✓	✓		✓
Bangladesh Forest Research Institute (BFRI)	✓			✓	✓	✓
Bangladesh Livestock Research Institute (BLRI)	✓		✓	✓	✓	✓
Bangladesh Fisheries Research Institute (BFRI)	✓			✓	✓	✓
Bangladesh Tea Research Institute (BTRI)	✓			✓		✓
B'desh Sericulture Research & Training Inst. (BSRTI)	✓			✓	✓	✓
Soil Resources Development Institute (SRDI)			✓			✓

Public Extension Service Providers (ESPs)

- **Department of Agriculture Extension (DAE).** Under the Ministry of Agriculture, the DAE is mandated to provide extension services throughout the country. DAE has a network of 75 horticultural nurseries throughout the country that produce seed,

vegetable seedlings and ornamental plants for sale to the public. Ultimately, DAE is responsible to do the extension work in all over Bangladesh through its field services wing with more than 12,000 staff.

- **Department of Livestock Services (DLS).** The DLS has been working under the Ministry of Livestock and Fisheries to provide livestock extension services. It has offices up to the Upazilla level. Moreover, it has farms for the purpose of breeding and production.
- **Department of Fisheries (DoF).** It has mandate on aquaculture extension throughout the country. Extension services are provided by various administrative offices up to the Upazilla level.

Other public agencies in Agricultural Technology System

- **Agricultural Universities:** Conduct research on variety development. Occasionally, universities do collaborate with the private sector in developing technologies but it remains sporadic.
- **Bangladesh Agricultural Development Corporation (BADC).** It produces foundation seed using breeder seed received from the ARIs. It maintains 21 seed multiplication farms and 12 seed processing centres and uses almost 60 000 smallholders as contract growers for production of certified seed. It produces seed of cereals (rice, wheat and maize), potato, jute, pulses and oilseeds, vegetables and spices. It supplies about 20 percent of the country's cereal seed requirements and about 2–5 percent of seed of other crops. It has about 1300 licensed dealers for marketing certified seed, including registered private seed dealers and NGOs.
- **National Seed Board (NSB).** The NSB is a statutory body comprising 21 representatives from various official institutions and the private seed sector. NSB is the apex body which finally approves any variety release.
- **Seed Certification Agency (SCA).** The SCA, established in 1974, is the statutory body under the MOA's Seed Wing which authorizes seed certification and variety release. It coordinates technical committee meetings, and field evaluation and the variety release system through its field inspection wing.
- **Livestock Research Institute (LRI).** This particular institution manufactures vaccines for both poultry and livestock. Farmers can access these low cost vaccines through various administrative offices throughout the country.

Appendix 2: Intervention Logic Analysis

1. Problem/ Issue	2. Underlying Causes	3. Services/ 4. Enabling Environment (that could overcome problem)	5. Weaknesses	6. Interventions	Actors	Take forward?	Systemic Thinking
1. Farmers are not sufficiently aware of technology opportunities	The extension service is promoting mostly Government research technologies and is missing the private sector interests This results in limited promotion of new technologies	Promotion	Exhibitions are mainly driven by Government programs	Involvement of private sector in the design of Upazilla agriculture exhibitions	Upazilla Parishad, Bangladesh Seed Association (BSA); Machinery Association; Farmer's Association (local)	yes	The fairs will help promote the technologies and increase sales - therefore there will be a constant interest of the technology associations and the companies to be part of this. They will continually push the government to be part of this to ensure more private sector involvement.
	Machine manufacturers/ traders do not invest money or time in promoting their products						
2. Farmers lack regular or optimal access to technology based services	Often no proximate LSP in villages; farmers have to rent different services from surrounding village: (1) Lack of credit based services; (2) Lack of cooperative activities/ farmers association	Rental Coordination	Technical capacity of local LSPs is limited	Strengthen Retail Service	LSPs in finance, technology maintenance and repair; farmers associations and other local village groups	No - study is generic and this would require specific interventions for particular technologies	
	Ratio of service receivers to LSPs is often very high - the ratio of number of service provider to LSPs is around 50:1 in most cases: (1) capital shortage and lack of loan facilities; (2) machines have to run under continuously and thus often get out of order; (3) machines require after initial period of use (1-2 seasons) high repair cost (5000 to 7000 taka in each season); and the amount increases in each season); (4) LSPs cannot solve critical problems and farmers have to take their machines to Dhaka or Barisal - involves much time and expense	Financial (would cover the capital shortage and machine operation cause) Machine supply system would have be developed for the other causes, so would not be possible to propose this service within the limitations of the study	Credit-based services do not sufficiently support local enterprise models for technology service provision	covered through 9			
3. Adoption of lower quality technologies	Perverse incentives of local retailers to increase the margin whilst reducing quality through mixing impurities with seeds etc	Quality Monitoring	Lack of effective regulatory mechanism; lack of IPR system to protect new innovations	Enforcement of rules and establishment of effective monitoring body	Retail service; manufacturers and distributors; GoB regulatory and extension services	no - will be difficult keeping in mind the limiations of the study	
	Manufacturers compromising quality for price						
	No rules/ regulations protecting IPR						
	No body or committee to test and authorize the imported/ manufactured machines						
4. Demand forecasting information can be inaccurate	Erroneous demand forecasting as seed companies do not have any scientific mechanism or dedicated experts to forecast demand efficiently. Seed companies do not have any mechanism to monitor or observe the demand shift across the country	Market Information	Lack of capacity in private sector to accurately forecast demand; lack of such demand forecasting system	Provision of forecasting data system	BSA; DAE	Yes	Assessment will help companies to plan their production, which means they will avoid unnecessary costs in production making them more competitative. this would also help them not to have 'carry-over' production, thus improving the quality of the seeds. Any pilot should start with seed as field investigation revealed that the largest problem was evident in the seed sector
	Data provided by the Government is not seen as consistent by the private sector		Inconsistent access to GoB data at national/ district level				
	Seed companies are not been able to capture the true picture of what farmer want to produce or what seeds they want to sow		Lack of capacity to effectively understand farmer requirements				

1. Problem/ Issue	2. Underlying Causes	3. Services/ 4. Enabling Environment (that could overcome problem)	5. Weaknesses	6. Interventions	Actors	Take forward?	Systemic Thinking
5. Insufficient skills throughout sector	Manufacturers do not have the required engineering/ technical knowledge to imitate designs/ prototypes of imported technologies and DAE developed machines	Skills; Techniques/ knowledge; coordination	Lack of technical capacity in local informal manufacturing sector	Build capacity of people	Companies; Universities; GoB (particualrly ARIs)	No - too long term to achieve measurable impacts	
	Skilled persons leave the country		Lack of coordination between sector requirements and academic skills development				
6. Farmers do not receive reliable advice	Local retailers sell seeds and input for highest margin rather than highest benefit to customers due to incentives driven by commissions from supplying companies	Farm Information; knowledge	Lack of institutional mechanism in providing information services	Establish agri-clinics	Local private sector retailers; local expert; input companies	Yes	Experts (lead farmers, others etc) are incentivised by additional income; as there is no system on advice much advice is provided for free - an institutionalised system of advice on commercial model would improve the quality of advice in both depth (they go deeper into the problem with the farmers) and breadth (they give more time). The increased earning should attract other advice providers
	Lead farmers are in existence, but services by them are given based on 'social' relationships and is not institutionalized						
	The other sources of information, SAAOs are not easily accessible		Excess workload of SAAOs	Reduction of workload for SAAOs	Government	no - this would require a long time	
7. Predominance of demonstrations and subsidy models (promoting non-market incentives)	Proper homework on the impact of subsidy in particular technologies have not been undertaken. Lack of understanding of market system development within the government.	Coordination (among actors doing research and transfer);	Body to provide such analysis does not exist	Establish Analysis Centre	Could be housed within RDA or other bodies	Yes	With proper analysis if we could show to government that there is more value for money in research investments. Then key organisations such as RDA can actually influence the government through showing an evidence base for savings in investing in market systems development. The government would in future value this service and pay for more in-depth research and analysis. The Centre would constantly be looking for new low-cost technologies that farmers require - the private sector would be interested in the centre as it would get new ideas from the centre and would be prepared to pay part of the cost.
	Projects operate with technology transfer models (having an aim to equip farmers with technoloogy, rather than working on systems). This fails to strengthen ancillary services in the market system. Without these supporting functions the commercial models are often too weak to function effectively			The establishmen of the center could also help the projects (donors) to coordinate with such a center			
8. Farmers' lack of confidence in output markets	The rates of product and the quantity does not remain the same for farmers, so they become risk averse.	Contract Farming: crop promotion	Model being practiced, but all farmers prefer independency in markets	Crop sector development	All value chain actors	No - too sector specific and long-term	

1. Problem/ Issue	2. Underlying Causes	3. Services/ 4. Enabling Environment (that could overcome problem)	5. Weaknesses	6. Interventions	Actors	Take forward?	Systemic Thinking
9. Poor access to effective forms of credit	Lack of flexible credit facilities in purchasing machines – ie Importers/ dealers do not sell machines on instalments (unless there is a close family relationship) - Government loans are not flexible or easily manageable: (1) high interest rate; (2) lengthy paperwork and procedures; (3) have to bribe in different channels - NGO provided loans are also often problematic: (1) loan amounts are usually small (unless the seeker has been involved with that NGO for long tome); (2) high interest rate and instalment frequency	(effective) Finance	Lack of commercial private sector financing models; government and NGO financing options not flexible enough for farmers' needs	Strengthening of technology financial product	Commercial Financial Service Providers (FSPs)	Yes	Commercial banks are increasingly becoming aware of the business potential of rural markets, which have long been the domain of MFIs. These banks require support to ensure effective risk mitigation strategies are in place to operate in the rural market sector. The banks need to develop financial products to stimulate demand for low cost technologies.
10. Lack of holistic view of the market system	Most of the dissemination on technology promotion is done through promotion/extension. This misses out the crtical component on the other bits of the market system	Coordination (among actors doing research and transfer);	Covered through 7				
	Most of the Government research seems to lack the socio-economic research and is focused on scientific research	Skills	Covered through 5				
11. Lack of functioning Intellectual Property Rights (IPR) system	There is weak enforcement	IPR Enforcement	Lobby for strong enforcement also seems to be weak	Strong private sector lobby for IPR system enforcement	All private value chain actors	No - too sector specific and long-term	

Appendix 3: List of Respondents

FARMERS AND SERVICE PROVIDERS:

Uttar Madrasa Char, Charfashion, Bhola:

- Abdul Sattar Faruk
- Md Solaiman
- Wahid Ali
- Faruk Bepari
- Md. Hafez
- Nurul Islam Sardar
- Md. Alauddin
- Md. Salauddin
- Moulovi Hafez
- Kuddus Miah
- Hafizuddin
- Barek Miah
- Solaiman Hoque
- Mobarak Ali
- Sattar Miah
- Nuruzzaman Talukdar
- Ponkoj Kanti Dhor
- Rahim Billah
- Keramot Bepari

Shibpur, Doulotkhan, Bhola:

- Goni Member
- Rahman talukdar
- Komol Kanti Bishwas
- Chan Miah
- Shona Miah
- Nurul Hoque
- Abdul Hoque
- Md hakimuzzaman
- Md Shahabuddin
- Saiful Hoque
- Hasen Uddin
- Hosen Ali
- Md. Bodruddin
- Md. Rokanuzzaman
- Shaheb Bepari
- Rahman Billah
- Moazzem Hoque
- Moinul Islam
- Montu Bishwas
- Md. Mofizuddin

Shonaikuri, Baliakandi, Rajbari:

- Shopon Kumar Bishwas
- Akhil Kumar Roy
- Arvinda Roy
- Binay Kumar Bishwas
- Sunil Kumar Roy
- Dilip Bishwas
- Ranjit Bishwas
- Shohidul Islam
- Shonjoy Momdol
- Chitto Roy
- Shubodh Bishwas
- Apurbo Mondol

Jhajaritola Bazar, Barisal Sadar, Barisal:

- Md. Sekandar Sarker
- Haider Mridha
- Chunnu Sardar
- Habibur Rahman
- Abdul malek
- Sultan Haoladar
- Mizanur Rahman
- Farik Sarder
- Md. Kazimuddin
- Nizamuddin Sardar

Khantopur, Gouronadi, Barisal:

- Abdul Karim Haoladar
- Md. Harun-Ar-Rashid
- Abdul Kader Haoladar
- Shree Gautam Datta
- Md. Jasim Uddin Mridha
- Sanjay Kumar Das
- Kaes Haoladar

Talma, Nagarkanda, Faridpur:

- Sobhan Bhuiyan
- Abu Bakar
- Md. Tara
- Nazrul Islam
- Sarwar Bhuiyan
- Md. Siddique
- Md. Kawsar

Paglimer haat, Domer Upazila, Nilphamari

- Abul Hossain
- Taslim Uddin
- Rafiqul Hossain
- Moksed Ali
- Md. Haliur Rahman
- Md. Oliur Rahman
- Abdul Mannan Ali
- Shafiqul Islam
- Aminul Islam
- Monower Rahman
- Fazier Rahman
- Ohadul Islam

Morahati, Mithapukur upazila, Rangpur:

- Md. Anisur Rahman
- Md. Nur Imam (Babul)
- Md. Shahdat Hossain Babu
- Md. Hannan
- Nur Islam
- Abul Kashem
- Moksed Ali
- Ajahar Ali
- Shahidul Islam
- Shafikul Islam

Jessore Sadar, Jessore:

- Torab Ali Mollah
- Rafiqul Islam
- Kalam Mia
- Nur Islam
- Zaman Miah
- Salam Gazi
- Md. Faruque Hossain
- Nasir Uddin
- Md. Imran Ali
- Moslem Uddin
- Soleman Miah
- Md. Hazrat Ali
- Tara Miah
- Kawser Uddin
- Md. Abu baor
- Md. Mosharraf Hossain

Dumuria and Botiaghata, Khulna:

- Md. Moksed Ali
- Rabindra Nath Mondol
- Sabuj Sharker
- Uttam Mondol
- Jatindra Nath Mondol
- Firoz Khan
- Rezaul Khan
- Md. Ziaur Rahman Khan
- Abdur Rashid Khan
- Aslam Khan
- Jahidur Rahman
- Khan Jahan
- Masudur Rahman Khan
- Md. Hafizur Rahman
- Md. Usuf
- Bijoy Krishno das
- Biplob Kumer Das
- Binod Das
- S. M. Nurul haque
- Milon das
- Bipul Das
- Samir Das
- Masud Sheikh

AGRO-MACHINERY MECHANIC:

- Shuranjan Biswas, Archarpara, Moksedpur, Gopalganj
- Nikhil Chondro Dhor, Talma, Nagarkanda, Faridpur

- Pronob Kanti Biswas, Shonaikuri, Baliakandi, Rajbari
- Md. Shaheen Mridha, Mukundopotti, Sada, Barisal
- Abul Kashem Sardar, Masjidbari, Kalkini, Madaripur
- Lokman Hossain, Sadar, Jessore
- Pankaj Barua, Sadar, Jessore
- Md. Habibur Rahman, Nahar Engineering Workshop, Sher-e-Bangla road, Khulna
- Arun Biswas, Bhai Bhai Machineries Workshop, Dumuria, Khulna

AGRICULTURAL MACHINERY MANUFACTURER/ WORKSHOP:

- R.K. Metal, Tepakhola, Faridpur
- Faridpur Engineering Workshop, Goalchamot, Faridpur Sadar, Faridpur
- Ma Metal Enterprise, Ambikapur Bazar, Faridpur Sadar, Faridpur
- Mahbub Engineering Workshop, BISIC, Jamalpur
- Rahman Engineering Works, Veramara, Kushtia
- Alim Industries Limited, Sadar,Sylhet
- Alam Engineering Workshop, Nawabpur, Dhaka
- Rifat Engineering Workshop, Vurghata, Kalkini, Madaripur
- Haoladar Engineering Workshop, Beauty road, Sadar, Barisal
- Biplab Engineering Workshop, Beauty road, Sadar, Barisal
- Khaja Mechanical Engineering Workshop, Vurghata, Kalkini, Madaripur
- Saiful Islam Mollik, Khulna Sadar, Khulna
- R. G. metal House, Chuknagar bazaar, Khulna
- Moni welding and works, Doulatpur, Khulna
- Ibrahim Engineering Workshop, Chachra more, Sadar, Jessore
- Chanchal Engineering Workshop, Chahchra, Sadar, Jessore
- Sheikh Akher Ali, Chachra, Sadar, Jessore
- Ripon Engineering Workshop, Rajar haat, Sadar, Jessore

AGRICULTURAL MACHINERY IMPORTER:

- Chittagong Builders, Nawabpur, Dhaka
- Green machineries, Nawabpur, Dhaka
- Mollah machineries, Nawabpur, Dhaka

AGRICULTURAL MACHINERY DEALER/ RETAILER:

Bhola:

- Johura Machineries and Spare parts, Charfashion, Vola
- Dolphin Machineries and Spare parts, Vola sadar, Vola
- Zakaria Machineries, Vla Sadar, Vola

Faridpur:

- Taz Motors, Goalchamot, Faridpur Sadar, Faridpur
- Zakir Machineries, Goalchamot, Faridpur Sadar, Faridpur

- Faridpur Machineries, Hajratola, Faridpur Sadar, Faridpur
- Trinath Machineries, Tekerhaat, Rajoir, Madaripur
- S.R. Motors, Khalia, Rajoir, Madaripur

Barisal:

- Shahidul machinery Store, Gouronodi, Barisal
- Islamia Machinery Store, Gouronodi, Barisal
- Mazid and Co., Port Road, Masjid market, Barisal
- Messrs Machinery Store, Hazrat Maolana Enayetur Rahman Road, Barisal
- Shagor Machinery Store, Gouronadi, Barisal

Rajbari:

- Faruk Machineries, Shonapur Bazar, Baliakandi, Rajbari
- Krishi Sheba Bitan, Biruli bazaar, Baliakandi, Rajbari

Khulna:

- Jalal Machineries, Bagerhat, Khulna
- Progoti Sanitary, Dumuria, Khulna
- Kakoli Traders, Chuknagar bazaar, Khulna
- Tumpa Enterprise, Chuknagar Bazaar, Khulna
- Mrs. Al Shahin Traders, Fakirhat, bagerhaat, Khulna
- Saddam Machineries, Khan A Sabur road, Power House, Khulna
- Khulna Builders and Machineries, Khan A Sabur Road, Power house, Khulna
- Motiar machineries, Chuknagar Bazaar, Khulna
- Bhai Bhai Machineries, Chuknagar Bazaar, Khulna
- Alam Machineries, Power House, Khulna
- Sumi Auto Parts Corner, Chuknagar Bazaar, Khulna
- Zaman Machineries, Power House, Khulna
- Imran Traders, Khan jahan Ali road, Khulna

Jessore:

- Agro Equipments Limited, Chachra, Sadar, Jessore
- National Trading, Sadar, Jessore
- Mrs. Islam Traders, Sadar, Jessore
- New Jesco traders, Pipe potti, Sadar, Jessore
- Mohammad Traders, RN road, Sadar, Jessore
- Samson Traders, RN road, Sadar, Jessore
- Noman Traders, Chachra, Sadar, Jessore
- Jessore Auto Parts, Rail road, Sadar, Jessore

DAE:

- Md. Harun-ur-Rashid, UAO, Faridpur Sadar, Faridpur
- Md. Feroz Rahman, SAAO, Faridpur Sadar, Faridpur
- Md. Wahiduzzaman, UAO, Nagarkanda, Faridpur
- A.K.M. Manirul Alam, UAO, Barisal Sadar, Barisal
- Rattan Kumar Das, UAO, Gouranadi, Barisal
- Bijay Krishna Biswas,UAO, Baliakandi, Rajbari

- Md. Ferdous, UAO, Khulna Sadar, Khulna
- Pankaj Kanti Mojumder, UAO, Dumuria, Khulna
- Shotto Broto Nag, UAO, Rupsha, Khulna
- Abdul Kader, SAAO, Telgati, Khulna Sadar, Khulna
- Sheikh Rafiqul Islam, SAAO, Dighalia, Khulna Sadar, Khulna
- Md. Helal Uddin, Agricultural Engineer, DD Office, Jessore
- Pradip Kumar Mondol, SAAO, Munirampur, Jessore
- Fazila Banu, SAAO, Chehelgazi, Sadar Upazila, Dinajpur

MFIs:

- Krishi Bank, Nagar Kanda, Faridpur
- BRAC SME, Faridpur Sadar, Faridpur
- Krishi Bank, Gouronodi, Barisal
- BRAC SME, Barisal Sadar, Barisal
- Commerce Bank, Dolotpur, Khulna
- Krishi Bank, Sadar, Khulna
- Sonali Bank, Sadar, Jessore
- Jagoroni Chakra, Sadar, jessore

ARIs/ BARC/ DAE HQ/ Others:

- AHM Kamal, Coordinator, Shouhardo, CBHQ, Kawranbazar, Dhaka
- Dr. Arifur Rahman Siddique, Senior Program Officer, Danish Embassy
- Engr. Subrata Ranjan Das, Business Manager, ACI Motors, Dhaka
- S.M. Abdul Mukit, Asstt. Manager (Institutional Sales), Laal Teer Seeds Ltd., Dhaka
- Mr. Ali Asgar, Director, Hatim Pipes, Dhaka
- Dr. M Enamul Haque Azad, Product Manager, Bengal Overseas Limited (Intervet), Dhaka
- Sheikh Md. Nazim Uddin, Project Director, AETEP Project (Agri. Machinery), DAE, Dhaka
- Engr. Md. Alamgir Hossain Khan, Project Director, AETEP Project (IWM), DAE, Dhaka
- Dr. Shafiqul Islam, Chief Engineer, Farm Mechanization Project, DAE, Dhaka
- Dr, Sultan Ahmmed, PSO & Head of Agri. Engineering, BARC, Dhaka
- Dr. Kshirode Chandra Roy, Ex. DG, BARI, Gazipur
- Dr. Wahab, PSO, BARI, Gazipur
- Dr. Abdur Razzaque Akand, PSO, BARI, Gazipur
- Engr. Md. Shoeb Hassan , CSO & Head, FPM Engineering Division
- Dr. Israel Hossain, PSO, Wheat Research Center, Rajshahi
- Arun Saha, ADB
- Mark Visocky, USAID
- Michael Lipton, iDE-UK Director