SUSTAINABILITY OF SMALLHOLDER SEED ENTERPRISES IN BANGLADESH

MD. SADDAM HOSSEN

DEPARTMENT OFAGRICULTURAL EXTENSION AND INFORMATION SYSTEM
SHER-E-BANGLA AGRICULTURAL UNIVERSITY
DHAKA – 1207

DECEMBER, 2016

SUSTAINABILITY OF SMALLHOLDER SEED ENTERPRISES IN BANGLADESH

BY

MD. SADDAM HOSSEN

REG. NO.: 15-06988

A thesis
Submitted to the Faculty of Agriculture
Sher-e-Bangla Agricultural University, Dhaka-1207
In partial fulfilment of the requirements
for the degree of

MASTER OF SCIENCE (MS)
IN
AGRICULTURAL EXTENSION AND INFORMATION SYSTEM
SEMESTER: JULY-DECEMBER, 2016

APPROVED BY:

(Dr. Ranjan Roy)
Supervisor
Associate Professor
Dept. of Agricultural Extension and Information System
Sher-e-Bangla Agricultural University
Dhaka

(M. Zahidul Haque)
Co-supervisor
Professor
Dept. of Agricultural Extension and Information System
Sher-e-Bangla Agricultural University
Dhaka

`

(Dr. Md. Mahbubul Alam)
Chairman of Supervisory Committee
Associate Professor
Dept. of Agricultural Extension and Information System
Sher-e-Bangla Agricultural University
Dhaka

DEDICATED TO MY BELOVED PARENTS

CERTIFICATE

This is to certify that the thesis entitled **"SUSTAINABILITY OF SMALLHOLDER SEED ENTERPRISES IN BANGLADESH"** submitted to the faculty of agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfilment of the requirement for the degree of **Master of Science** in **Agricultural Extension And Information System**, embodies the result of a piece of bona fide research work carried out by **MD. SADDAM HOSSEN**, Registration No.15-06988 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this investigation has been duly acknowledged.

Dated: December 2016
Dhaka, Bangladesh

Dr. Ranjan Roy
Supervisor
Associate Professor

DEPARTMENT OF AGRICULTURAL EXTENSION
AND INFORMATION SYSTEM
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207

ACKNOWLEDGEMENT

At the beginning, the author expresses his thankfulness to the “Almighty Allah” who enables him to complete this thesis. It is his proud privilege to express his deep sense of gratitude, profound appreciation and immense indebtedness to the Chairman of the Supervisory Committee, Dr. Ranjan Roy, Associate Professor, Department of Agricultural Extension and Information System, Sher-e- Bangla Agricultural university, Sher-e- Bangla Nagar, Dhaka for his scholastic guidance and suggestions, untiring assistance and continuous inspiration throughout the whole period of the study. His generous encouragement created a keen interest, which enabled the researcher to tackle various difficulties successfully during the course of this research work.

The author is deeply indebted to Professor M. Zahidul Haque, Department of Agricultural Extension and Information System, Sher-e- Bangla Agricultural University, Sher-e- Bangla Nagar, Dhaka for his advice, sincere cooperation and suggestions in connection with this piece of research work.

The author is especially grateful to all the teachers and stuffs department of Agricultural Extension and Information System, Sher-e- Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka for their advice and sincere cooperation during the completion of the study.

The author is grateful to the respondents of the selected areas for rendering co-operation and giving their valuable time for interview during collection of data.

The author also expresses his heartfelt thanks to his friends and family members for their blessing, sacrifices, support and help for the completion of the study.

The Author

December, 2016

SUSTAINABILITY OF SMALLHOLDER SEED ENTERPRISES IN BANGLADESH[1]

MD. SADDAM HOSSEN[2]

ABSTRACT

Smallholders seed cultivation, processing, and marketing of major crops such as rice, wheat and maize have been largely a neglected issue of the government, despite Food and Agriculture Organization reports that the smallholders seed enterprise (SSEs) are the best way of ensuring the availability and quality of non-hybrid seeds. The concept SSE is built around the notion of seed production by smallholders with a view to fulfill their own demand, sell in the local market and foster a commercial perspective in the informal seed system (i.e., beyond government's initiatives for seed production and development). The objectives of the study were to develop a set of indicators of sustainable SSEs, evaluate sustainability of SSEs, and formulate policy information. The study assessed the sustainability of SSEs by constructing composite indicators (CIs), consisting three dimensions: social, economic and institution. Data were collected from 120 smallholders of six villages of Nagarpur (Tangail) and Shahjadpur (Shirajganj) upazilas. A number of statistical tools, namely, multiple regression analysis and methods such as developing CIs were employed to produce the results and findings. The study results indicate that (i) an overwhelming majority (92.5%) of the smallholder had moderate to highly sustainable seed enterprises, in terms of the selected nine indicators of dimensions and (ii) highly contributing (based on standardized coefficients) indicators were institutional function, marketing prices of seeds, human capital, and marketing facility. The findings conclude that existing institutions (like market) that facilitate agricultural development play a key role in achieving the sustainability of SSEs. Policy should place emphasis on enhancing institutional commitment, coordination and cooperation in providing necessary services for seed cultivation, post-harvest and marketing.

Key words: Sustainability, Smallholder seed enterprises, Composite indicator (CI)

---

[1]Title of the MS thesis presented on December 2016

[2]Name of the thesis presenter, department of Agricultural Extension and Information System, Sher-e- Bangla Agricultural University, Dhaka-1207

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX

Abbreviations and Acronyms

AAS	Agricultural Advisory Society
BADC	Bangladesh Agricultural Development Corporation
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
CGRFA	Commission on Genetic Resources for Food and Agriculture
CI	Composite Indicator
DAE	Department of Agricultural Organization
DFID	Department of International Development
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
HYV	High Yielding Varieties
IDA	International Development Association
IRRI	International Rice Research Institute
MDGs	Millennium Development Goals
MoA	Ministry of Agriculture
NGOs	Non-Government Organization
NRC	National Research Council
NSP	National Seed Policy
OECD	Organisation for Economic Co-operation and Development
PETRRA	Poverty Elimination through Rice Research Assistance
SSEs	Smallholder Seed Enterprises
RIGA	Rural Income Generating Activities
RNF	Rural Non-farm
SHOGORIP	Shoshsho Gudam Rin Prokolpo

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Seeds are basic agricultural input. Quality seeds of any preferred variety are a basis of improved agricultural productivity since these seeds respond to farmers' needs for both their increasing productivity and crop quality (Pelmer, 2005). Over 90% of the crops in developing countries are still planted with farmers' varieties and farm-saved seeds (Almekinders et al., 1994; Almekinders and Louwaars, 1999; Maredia et al., 1999; World Bank, 1998). As a result, large international seed companies concentrate on those countries with large commercial seed sectors, often focusing on high value crops grown by larger farmers in more favourable areas, i.e. targeting those who are best able to pay for their seed. They tend to avoid self-pollinating crops (Rice, wheat, etc.) including many of the crops smallholder farmers grow and on which they depend for their food security because these are the crops for which farmers save their own seeds, reducing opportunities for commercial seed production of these crops. In the past, the public sector universities, governmental organizations and international organizations were major sources of new varieties and quality seeds of food crops for the smallholder farming sector, especially with regards to self-pollinating crops. However, in recent years, many countries have encouraged privatization or commercialization of public sector seed activities, while international organizations have faced budget constraints, leading to reduced investment in public-sector plant breeding and seed production enterprises. As a consequence, public-sector seed activities have tended to focus on a narrow range of crops grown by larger farmers. In this way, reducing supplies of seed of new varieties of subsistence crops to smallholder farmers even further (Bengtsson, 2007). Nevertheless, there are a number of examples throughout the world where seeds of cultivars are supplied by successful small to medium-scale seed enterprises or farmer organizations. The Food and Agriculture Organization (FAO) regards the Smallholder Seed Enterprises (SSEs) as the best way of ensuring the availability and quality of non-hybrid seeds for food and feed crops in developing countries as they recognize the contribution of smallholder seed enterprises in addressing global challenges, such as achieving the Millennium

Development Goals (MDGs), adaptation to climate change and the attainment of food and nutrition security (FAO, 2010). Sustaining the growth of smallholder seed enterprises through the promotion of public and private partnerships and capacity building is focus area of FAO.

1.1.1 The Meaning of Smallholders

The term 'smallholder farmer' varies among countries and ecological zones due to different factors such as crop types, area cultivated and production. People who participate in the day to day activities by providing labour and management of the farm/livestock can be considered as smallholder farmers (Babu and Sanyal, 2010). The World Development Report 2008 states that the largest proportion of farmers in developing countries is smallholders and about 85% of them are farming in less than two hectares of land (World Bank, 2007). According to this report, in countries such as China, Egypt, Bangladesh and Malawi, smallholder farms with less than two hectares of farm land account for 95% of the total.

The simplest and conventional meaning of a smallholder is the case when the land available for a farmer is very limited (Chamberlin, 2008:3 and Hazell et al., 2007:1). However, the meaning goes far beyond this conventional definition and consists of some general characteristics that the so called small farms or smallholders generally exhibit. Chamberlin has identified four themes on the basis of which smallholders can be differentiated from others. These themes include landholding size, wealth, market orientation, and level of vulnerability to risk. Accordingly, the smallholder is the one with limited land availability, poor resource endowments, subsistence oriented and highly vulnerable to risk. Nevertheless, the smallholder may or may not exhibit all these dimensions of smallness simultaneously.

1.1.2 Smallholder Seed Enterprises (SSEs)

Small enterprises may be suited to smallholder communities because seed selection and seed usage are location-specific, with particular varieties. Neck (1977) stated that small enterprises are those in which the management lies in the hands of one or two are also responsible for the major decisions. Smallholder seed enterprises (SSEs) is a

commercial perspective in the informal seed system through which it provides entrepreneurial skills, management expertise and financial resources to local communities, farmer cooperatives, NGOs or other groups interested in producing seed for the local market. Their advantage lies in their ability to serve remote areas, work in close partnership with local farmers, produce seeds of diverse varieties including landraces, local varieties, farmer bred varieties and populations, and thus increasing the supply of seeds of a large number of locally adapted varieties. Smallholder seed enterprises focus on national food security, contribution on economic growth and ensuring social and environmental sustainability of the agricultural sector.

1.1.3 Demand and supply of quality seed

Quality seed is one of the most important agricultural inputs to ensure food security. Quality seed production and preservation at farmers' level following the modern techniques can minimize the seed shortage as well as storage losses (Islam et al., 2010).Use of quality seed only can enhance the productivity by 5-20 percent (IRRI, 2013). In the recent years, supply of quality seed both from public and private sector has increased. The quantity of seed supply was 240475 mt. in 2009-10. Seed supply quantity has increased to 267777 mt. in 2012-13, which is 21 % of the total demand. But in real situation, it is much better, because rice is our main crop and in case of rice, the quantity of quality seed supply is almost 60%, in-case of wheat is 56%, maize 75%, Jute 83% etc. The total average goes down due to less supply of spices and oil seed. The quality is also less in case of potato. Actually BADC supplies only 2-3% of quality potato seed, and the rest of the seed comes from the farmers own production. If supply of seeds can be increased up to 30% (which is projected in 2015) that will be a great success for the agriculture sector of the country. [Source: MoA, 2014]

1.2 Statement of the problem

Although most seeds are still farm-saved, increasing numbers of farmers buy commercial seeds of their food crops (Joshi G. R., 2011). Mele *et al*. (2005) reported that poor farmers need better and more affordable access to quality seed in order to

improve their livelihood. Probert *et al*. (2007) reported that the quality of seed conservation, collection, and hence their value for species reintroduction or restoration, is critically dependent on factors operating in the period between the point of collection and arrival at environmentally controlled processing and storage facilities. The major issues related to processing plants and storage capacity in public sector, low capacity available at private sector for processing/conditioning, low investment in seed infrastructure and poor seed processing procedures and quality measurement. There are also barriers for marketing of seeds. This includes lack of proactive marketing mechanisms and poor availability of quality products. The major issues on marketing are inadequate seed dealers, channels and networks, lack of promotion and advertisement campaigns, excessive flow of exotic hybrids and other crop seeds (maize, vegetables and forage crops), absence of improper labeling and inappropriate size of seed containers, un-affordable pricing of seed packets, high competition with imported seeds, and limited seed quality services. Bangladeshi agriculture is yet to witness modernization and competitiveness in terms of achieving national goal of food and nutritional security.

Therefore, it is imperative that research works, like this one, identify the factors determining the participation (or non-participation) of smallholder farmers in the output markets, analyze what factors affects the degree of sustainability of smallholder farms, and evaluate if market participants are better-off in terms of welfare outcomes. Such analysis "will help to design appropriate policy instruments, institutions and other interventions for sustainable economic development of smallholder farmers" (Betre A., 2006).

1.3 Objectives of the research

I. To determine a set of indicators of smallholder seed enterprise.
II. To assess the sustainability of smallholder seed enterprise.
III. To formulate policy information for making the smallholder seed enterprise sustainable in Bangladesh.

1.4 Research question

I. What are the indicators of smallholder seed enterprises sustainability?
II. What are the challenges and factors that influences sustainability of smallholder seed enterprises?
III. What policy information is needed to promote the sustainability of smallholder seed enterprises in Bangladesh?

1.5 Justification of the Research

Many countries and international development agencies give due concern to intensification and commercialization of smallholder agriculture as a means of achieving poverty reduction; and thus they have reflected it in their official policies (Leavy and Poulton, 2007:2). In Bangladesh, government institutions have until recently been responsible for seed production and seed supply. In the late 1980's, the private sector therefore only supplied about 5% of the total requirement for seed. The national seed policy (NSP) of 1993 and seed rules of 1998 paved the way for active participation of the private sector and non-governmental organizations (NGOs) in seed production. Government of Bangladesh provided a conducive environment for investment and initiative in the private seed sector. The food and agriculture organization supported the strengthening of the national vegetable seed program (1986-1993), working with Bangladesh agricultural development corporation (BADC), Bangladesh agricultural research institute (BARI) and department of agricultural extension (DAE). Danida supported seed industry development through their sector-wide support activities in agriculture and worked with all the players in the seed industry (2002-2006). The world banks' four seeds projects were approved in the period 1973 to 1978, and closed from 1982 to 1985. They were similar in concept, concerned to ensure that a seed multiplication and marketing system was in place to provide Green Revolution, High Yielding Variety (HYV) seeds to farmers. The Bangladesh Cereal Seeds Project (Credit 0410-BAN) was supported by an IDA credit equivalent approved in June 1973. This project in Bangladesh provided the first donor assistance to the seeds sector, a "rock" on which many other donors have subsequently built. The support for the Bangladesh Rice Research Institute was entirely appropriate;

and the support of the Bangladesh Agricultural Development Corporation's (BADC) seed-wing, played a constructive role in supplying seeds to the smallholder farmers level. Bangladesh has not benefitted from the competition within the public sector, and hence the expansion of a private sector seed industry has been slower than in India and Pakistan. Breeder seed supply by ARIs to BADC is inadequate due to lack of physical facilities and manpower and funding constraints. It is almost impossible for agencies to solve the full range of seed related problems unassisted. Activities of government, private sector, NGOs and farmers need co-ordination which yet to be established successfully. There is need to develop effective policy instruments and linkage with universities, private sectors, NGOs and most importantly the smallholder farmers to promote the sustainability of smallholder seed enterprises.

1.6 Scope of the Study

Bangladesh is primarily an agro based country with agriculture accounting for 23% of the country's gross domestic product (GDP). Agricultural production can be increased by 15-20% through use of quality seed keeping other things constant. Bangladesh as an agrarian country its employment, export and almost all activities related to economic development depends on Agriculture. Bangladesh agriculture has made enormous strides in the last 39 years, raising food grains production from 70 lakh mt. ton to 3 core 66 lakh mt. ton. (MoA, 2014). Seed production, processing and storage require elaborate infrastructure and sizeable capital, beyond the capacity of most NGOs and private sector enterprises. Farmers themselves supply most seeds but since they have inadequate knowledge of producing and preserving good seeds, quality of seeds at farmers' level deteriorates very fast.

The finding of the study will be especially applicable to the six villages under Nagarpur and Shahjadpur upazila in Tangail and Shirajganj district respectively. The findings will also have implications and applicability for other areas of the country, having similarities in physical, socio-economic and socio-cultural conditions with the study area. The findings of the study are expected to provide useful policy information to the researchers, academicians and policy makers who are concerned with sustainability of smallholder seed enterprises.

1.7 Assumptions of the Study

The researcher had the following assumptions in mind while undertaking this study.

1. The respondents selected for the study were competent for providing appropriate answer to the queries made by the researcher.
2. Questions and scales used for measuring the variables were enough to get the real views and opinions from the respondents.
3. Views and Opinions provided by the respondents were representative of the whole population of the study area.
4. The respondents were capable of furnishing proper answers to the questions contained in the interview schedule.
5. The researcher was well adjusted to himself with the social contiguous of the study area. Hence, the collected data from the respondents were free from favoritism.

1.8 Limitations of the Study

As far as research is concerned, there would always be certain limitations. This study has also encountered certain challenges in the course of collecting data from the study areas. Considering the time, money and other necessary resources available to make the study manageable and meaningful, it was necessary to consider the following limitations:

1. The study was confined mainly to some selected indicators of sustainability of smallholder seed enterprises.
2. The study was conducted only in six villages of only two upazilas of Tangail and Shirajganj district.
3. Characteristics of the farmers are many and varied but only some were selected for this study.
4. Facts and figures were collected by the investigator applied to the present situation in the selected area.

CHAPTER 2
REVIEW OF LITERATURE

2.1 Introduction

Reviewing relevant literatures and defining the theoretical framework, on the basis of which analysis of empirical data from the field is made, are core activities of any researcher in the social sciences. This section presents review of related literature in line with the objectives and research questions stipulated in the first chapter.

2.2.1 Sustainability

Sustainability means different things to different people. The concept of 'sustainability' is both ambitious and ambiguous and therefore, its precise definition is scarce. Generally, it is a capacity of any system (environmental, social and economic dimensions) that is capable to maintain and improve itself over the longer period of time (i.e. two generations). Sustainability has been described as the ability to obtain overarching societal aims in a way that can be maintained indefinitely without unwanted negative effects (NRC, 2010). For instance, agri-environmental sustainability is the capacity of farming systems to maintain themselves indefinitely by applying ecologically non-degrading agricultural practices that conserve and improve natural resources. Most definitions of sustainability are framed in terms of three broad social goals, namely economic, environmental and social health or well-being. In Europe, these three goals of sustainability are sometimes referred to as the 3Ps: people, prosperity and planet, or, alternatively, as the 'triple bottom line' (NRC, 2010). In defining sustainability, researchers put emphasis on various issues and reported that it: derives an ethical concern for future generations (Perman et al., 2003), has strong association with the economic concepts of production and utility functions (Pezzey, 2002), deduces from generic attributes of efficiency plus intergenerational equity (Stavins et al., 2002) and requires the long-term preservation of the viability of the systems (Spangenberg et al., 2002). However, three key points have emerged as vital for addressing sustainability: effective and efficient resource management, addressing intra-generational and inter-generational equity, and fulfilling long-term

criteria. The debate on 'sustainability' stresses several key points such as explicit discrepancy between the practical and theoretical sustainability (Van der Hamsvoort, 2006) and substantial dispute concerning the visions about the limits of economic growth and the carrying capacity of the Earth (Van Passel, 2007). In addition, keeping in mind the situational and contextual condition of diverse systems and processes, a number of issues are required to make sustainability operational that is essential for promoting sustainable production and consumption as well as development. These includes signifying the multidimensionality; effectively integrating the multiple spatial levels such as national, regional, local; emphasizing on the nested temporal scale; and focusing broad strategies.

2.2.2 Sustainable Development

Sustainable development is development which meets the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987).

In the extensive discussion and use of the concept since then (see e.g. Holmberg, 1992; Reed, 1997; Harris et al., 2001), there has been a growing recognition of three essential aspects of sustainable development:

Economic: An economically sustainable system must be able to produce goods and services on a continuing basis, to maintain manageable levels of government and external debt, and to avoid extreme sectorial imbalances which damage agricultural or industrial production.

Environmental: An environmentally sustainable system must maintain a stable resource base, avoiding over-exploitation of renewable resource systems or environmental sink functions, and depleting non-renewable resources only to the extent that investment is made in adequate substitutes. This includes maintenance of biodiversity, atmospheric stability, and other ecosystem functions not ordinarily classed as economic resources.

Social: A socially sustainable system must achieve fairness in distribution and opportunity, adequate provision of social services including health and education, gender equity, and political accountability and participation.

2.3 Formal and Informal Seed sectors

According to Almekinders (1999), the informal seed sector is usually defined as the total of seed production activities of farmers, mostly small-scale farmers. In contrast, the formal seed sector refers to seed production activities by the public and commercial sectors. Synonyms used for informal seed sector are local or farmers seed system(s). However, a clear-cut distinction between the informal and formal seed systems does not exist in the situations where public or private institutions are engaged in the production of uncertified, unlabeled or registered seed lots. Also, CGRFA (2011) argues that the formal seed supply system is highly regulated and involves a chain of activities leading to clear products which are certified seeds of verified varieties. The chain usually starts with plant breeding and selection, resulting in different types of varieties, including hybrids, and promotes advanced fixed germplasm materials leading to formal varieties release and maintenance. On the other hand, the informal seed supply system (or informal seed system) refers to the traditional arrangements used by farmers to supply the seeds they need to plant in the season. Other names given to informal seed supply systems include: farmer-managed seed system: farm-based; local seed production and supply; traditional seed system; and farmer's seed system (CGRFA, 2011).

2.4 Linkages between Formal and Informal Seed Sectors

Functional linkages between the formal and informal seed sectors enhance efficiency in the operation of both sectors and promote evolution of the seed sector (Smale et al., 2009b; Rubyogo et al., 2007; SEARICE, 2003; Tripp, 2003; World Bank, 1998; Maredia et al., 1999). The formal seed sector is the primary source of new crop varieties, and is home to most of the capacity in scientific plant breeding, extension services and credit. The informal sector is the primary link to farmer's traditional knowledge, especially requirements for new varieties, inputs and services. Strong smallholder seed enterprises can play a key role in linking the two sectors, if they have continuous access to improved varieties from public crop breeding programs (FAO, 2009). The relative importance of these two systems varies depending on the state of development of the agricultural system and the crops. About 80% of food production

reportedly comes from farmers with smallholding and the majority of farmers in developing countries use seeds from the informal seed system. Most of the seeds covered by this system fall within crop groups that are not of commercial interest to the private sector but the bulk of which constitute important food security crops. Contrary to conventional views, the formal and informal seed delivery systems coexist in large part in developing countries and in some cases in developed countries; farmers will usually resort to either or both of these systems for different crops and for different seasons (CGRFA,2011).

2.5 Global Picture of Seed Enterprises

There are thousands of seed banks around the world, and their carefully-stored catalogues are of vital importance to our species and the health of the ecosystems we occupy. As human continue to invade the diminishing wild areas of our planet, they risk biodiversity loss on an unprecedented scale (Sensi seeds, 2013).

Campesina L. V. (2013) stated that peasants, local, communities, subsistence and family farming still produce 75% of the food that is consumed on the planet, and 90% of non-mechanized non-motorized farmers of the world produce the majority of their seeds by themselves.

In most sub-Saharan African countries in the 1970s and 1980s, the Ministry of Agriculture or state-owned seed enterprises had a monopoly on the production and distribution of the seeds of the main crops, particularly the staple grain crops. In the late 1980s and during the 1990s, many African countries liberalized seed production and distribution, allowing local and international seed companies to enter the market. This trend has been stronger in East and southern Africa than in West Africa. In Kenya, liberalization led to the development of a competitive seed sector although the Kenya Seed Company continues to dominate the market (Ngugi 2004). In Tanzania, the state seed company, TANSEED, had a monopoly until the early 1990s. Since then international and local seed companies have begun producing and importing seed, mainly hybrid maize seed. In addition, NGOs have started community seed production in various locations (De Groote et al. 2002).

An early collection of studies by Bal and Douglas (1992) summarizes the experiences in the Gambia and Senegal with on-farm seed production. The projects were

supported by Winrock International, other NGOs, and the governments of the two countries. Technical training was provided in part through the Mississippi State University program. They argue that good quality seed of modern varieties (for non-hybrid maize, millet or sorghum, or self-pollinated crops, which aren't handled by private industry) can be produced through small farmers.

A successful example of small-farm seed production is the case of pigeonpeas in Kenya. Muh et al. (1997) report on the success of small-scale seed entrepreneurs in disseminating a new short-maturing variety of pigeonpea. ICRISAT and the Kenyan research institute carried out trials of a new short-maturing variety. One woman of those who participated in the trial provided the seed to 30 others along with extension advice. Within three years, these farmers became regular seed producers selling 900 kg of seed per year.

Kelly and Rusike (1997) provide an example of small-scale enterprise involvement in seed multiplication and distribution for southern Africa. The authors described the efforts of Agri-seeds (Agricultural Seeds and Services) in Zimbabwe to explore ways to produce seed through small-scale and communal farmers.

Ocran (1997) pointed out that in some cases, seed grower associations have developed into powerful cooperatives capable of determining seed prices and also acting as pressure groups to draw attention to their needs. He cited, for example, the large-scale seed cooperatives of Zimbabwe, smaller-scale cooperatives in Ghana, the Kenya Grain Growers Cooperative Union, and the Seed Producer Association of Zambia. He noted that there were many other formal and informal farmers' groups that were encouraged to affiliate themselves with the growers' associations and become recognized seed producers.

Recent research suggests that informal seed systems are quite resilient, more so than the formal seed systems. Evidence has revealed that the system tends to continue functioning even in disasters: even after major droughts or wars, seeds are often still available through the informal seed sector (FAO, 2004; Jones et al. 2002).

2.6 Evaluation of Seed Enterprises in South Asian Countries

The emergence of private seed companies and seed suppliers, complementing seed parastatal firms or other forms of public seed producing activities is a relatively recent

phenomenon in the Asia-Pacific region. This coincided with governments across the region revamping their seed systems and adopting new seed policies since the mid-1980s that 39 created favourable conditions for private sector investment in seed production and supply. Today the private sector contributes more than 40 percent of total seed production in India. It encompasses over 500 private seed companies, 24 of them with links to multinational seed companies, and many of them with their own breeding programs. However, the main focus of private seed companies has been on the high value crops such as hybrid cereals vegetables (notably in Southeast Asia) and industrial crops, such as cotton and soybean. The private sector will produce seeds of food crops only where there is sufficient demand to make it financially attractive, e.g. where there is a steady demand from relief agencies (notably in Africa) or where farming has intensified to the extent that farmers no longer save their own seeds (such as rice in parts of south and Southeast Asia). This means that seeds of any major food crops (self-fertilizing cereals and legumes) must either continue to be produced by public sector agencies (which have lost the profitable products that they formerly used to cross-subsidize production of these food crops), or must be produced by farmers themselves (Louwaars N., 2009).

Over 90% of the crops in developing countries are still planted with farmer's varieties and farm-saved seeds. Private seed companies tend to concentrate on production of hybrid seeds, especially of high-value crops grown by larger farmers in more favourable areas, i.e. targeting those who are best able to pay for the seeds. They tend to avoid self-pollinating crops, including many of those grown by smallholder farmers and on which they depend for their food security. Also for these crops, opportunities for commercial seed production are very limited because the biology makes it easy for farmers to save their own seeds for planting (FAO, 2009).

In Bangladesh, the public sector can meet up only 5-6% of the total rice seed demand, which is some 0.8 million tons every year. Bangladesh Agricultural Development Corporation (BADC) is the major supplier of this seed and therefore, it has the mandate to produce and supply quality seeds of the notified crops (rice, wheat, potato, jute and sugarcane). Private sector participation, which is relatively a new development, is mainly confined to the marketing of hybrid seeds of vegetables, corn,

oilseeds, fruits, and more recently, hybrid rice seeds that are being imported (Hossain *et al*., 2002). Over three years (2001-2004), the national NGO Agricultural Advisory Society (AAS) developed an innovative of decentralized quality seed production and distribution system in Bangladesh under the PETRRA (Poverty Elimination through Rice Research Assistance) project, called 'Farm seed'.

2.7 Major development in the seed industry in Bangladesh

The seed industry in Bangladesh comprises of both public and private sector initiatives. In the private sector, there are more than 100 companies involved, with over 5000 registered seed dealers operating across the country. The recent expansion of the private sector seed companies has resulted in the engagement of thousands of contract seed growing farmers into the formal seed production chain, leading to improved livelihoods amongst the rural community (Anon, 2007). PAN AP and GRAIN (2010) stated major development in the seed industry in Bangladesh in following

- The Bangladesh Agricultural Development Corporation (BADC) was established as the public sector institution with responsibility for multiplication, production and supply of seeds of high yielding varieties
- In the 1970s, key crop research institutes like Bangladesh Agricultural Research Institute (BARI) and Bangladesh Rice Research Institutes (BRRI) were established to develop new varieties of rice, wheat and other food crops and the supply of basic seeds for multiplication and distribution to farmers.
- The Seed Ordinance, the key seed law, was promulgated in 1977 (Amendments in 1997 and 2005).
- Under the structural adjustment program initiated by the government in the 1980s that saw downsizing of the public sector role in the economy, BADC started sharing the sale of seeds, fertilizers, and agricultural equipment with private sector companies.
- The National Seed Policy was promulgated in 1993 to pave the way for development of a seed industry in the private sector.

- BADC developed a partnership with the emerging private sector by allowing private companies and traders to use its seed processing centres for a fee. The services include seed drying, cleaning, grading, storing, germination, moisture, and purity testing.
- The seed of 1998 made provisions for active participation of the private companies and NGOs in the seed sector.
- In 2003, nearly 200 tons of hybrid rice seeds were sold in the country by BADC and BRAC, the two main agencies involved in hybrid rice seed production. A five year (1999-2004) project called poverty elimination through rice research assistance (PETRRA) funded by UK's DFID was implemented by IRRI and this encouraged farmers to grow rice seeds. In 2010, around 1000 tons of hybrid rice seeds were sold in the country mainly by private sector companies.
- The private seed sector in Bangladesh now includes over 100 domestic seed companies and their partnerships with multinational companies, 12 industry associations that promote seed business, and more than 20 NGOs with commercial operations in seed production and marketing.in private sector there are 5000 registered seed dealers operating around the country.

2.8 Barriers of seed enterprise

Muliokela (1998) lists a dozen reasons why smallholders may prefer recycled seed to purchased certified seed. Most of them fall into four categories:

i. Cost – Locally produced seed is almost always less expensive than formal-sector seed. This is particularly important for poor and risk-averse farmers.
ii. Familiarity – Farmers know the characteristics of recycled seed (particularly for self-pollinated varieties), but are generally less well certain about the characteristics of modern variety seed
iii. Performance under local conditions – Modern varieties produced by seed companies generally produce higher yields than local varieties in favorable environments with good soil, water, and fertilizer, but local varieties may

outperform modern varieties on farmer fields with little or no fertilizer, particularly in less favorable regions or in drought years (Almekinders 2001).

iv. Attributes other than yield – While modern varieties are bred for yield and disease/pest resistance, local varieties have been informally selected over time for a wider range of attributes that farmers value, including crop by-products (e.g. stalks for forage), ease of processing, and palatability.

2.9 Variable-wise Literature Review

2.9.1 Human capital

Leeuwis (2004) conducted research on human capacity that contributes in their productivity. He found that human capital is the total capability residing in individuals based on their stock of knowledge skills, health and nutrition. It is enhanced by access to services such as schools, medical services and adult training. People's productivity is increased by their capacity to interact with productive technologies and other people. Leadership and organizational skills are particularly important in making other resources more valuable.

Pretty et al. (2006) conducted a study on resource conserving agriculture. In their research they found that sustainable agricultural systems tend to have a positive effect on natural, social and human capital, while unsustainable ones feedback to deplete these assets, leaving fewer for future generations. Agricultural systems that offer labour absorption opportunities, through resource improvements or value-added activities, can boost local economies and help to reverse rural-to-urban migration patterns.

2.9.2 Income Generating Activities

Importance of non-farm income generating activities is found by different research done by Davis (2004) and Reardon et al. (2001). While agricultural related activities still constitute the largest share of total income among rural households, a number of empirical studies show the growing importance of RNF (Rural Non-farm) activities in developing and transition countries. Surveys of these studies indicate RNF income represents on average 42% of rural income in Africa, 32% in Asia, 40% in Latin America and 44% in Eastern Europe and CIS (commonwealth of independent states).

According to Carletto et al. (2007), the vast majority of rural households in each country of the RIGA (rural income generating activities) dataset participate in on farm activities. The share ranges from 54 to 99 percent by country, with an un-weighted average participation rate of 86.2 percent. For non-farm activities, the overall participation rate stands at about 47.7%, while the range of variation across countries is much greater than for agriculture.

2.9.3 Access to Financial Services

Improving access to credit is often regarded as one of the key elements in raising agricultural productivity (Machethe, 2004). In the stage of enterprise establishment, small scale farmers may depend on government grants, their own resources and/or those of friends and relatives.

Access to formal private financial services by smallholder farmers is constrained by high transaction costs, inadequate collateral and poor debt-servicing capacity (Fenwick and Lyne, 1998).

According to Jack (2005), cited by Zuwarimwe and Kirsten (2010), smallholder farmers still face problems in attracting external finance and other needed resources to establish and expand their businesses.

According to BBS (2007), farmers have very limited access to institutional credit because of collateral requirement. At present, only 27% of farmers receive institutional credit (BBS, 2007). The credit amount again is quite inadequate and not advanced in time. They are also not eligible for microcredit of NGOs that deal mainly with landless farmers.

2.9.4 Utilization of seed of improved cultivars

Farmers everywhere need easy access to high-quality seed of well-adapted, productive crops to allow them to produce the best possible crops, but efforts to encourage the private sector to play a role in ensuring efficient production and distribution of seeds in the developing world have yielded mixed results. The problems are complex as they combine both the reproductive mode of the major food security crops (mostly self-pollinated, open-pollinated and vegetative propagated crops), and the stage of agricultural development of the country (FAO, 2009).

The use of good quality seed of adopted and improved varieties is widely recognized as fundamental to ensure increased crop production and productivity. This is even more important in SSA (Sub-Saharan Africa) in the view of increasingly available land, declining soil fertility and ever growing population; those facts increase the importance of promotion and use of good quality seed as a means to intensify food production (FAO, 1999).

Improved seeds, such as hybrids or treated seeds are designed to adapt to local conditions and can also be resistant against fungus, pests and different diseases. Therefore, they are less sensitive to environmental changes and harsh weather conditions. In order to create hybrid seeds two or more different inbred lines are crossed (Smale et al., 2009). Treated seeds can be covered in a chemical solution, often fungicides or insecticides, prior to planting (McMullen et al., 2001). A disadvantage of improved seeds is that the ability to increase the yields drops when improved seeds are recycled (Smale et al., 2009). This means that if the seeds are planted a second or third time the yield will be lower than when the seeds are new. New seeds must therefore be purchased prior to each sowing period to get the higher yield.

2.9.5 Market prices of seeds

Small scale producers generally cannot compete with commercial farmers on price or volume, so they have to compete using other tools such as quality and service (Roos, 2010).

Mondal (2010) stated that Government is urged to procure the produces directly from the farmers raising the present ceiling to at least 10% of the total production. Storage faculties may at the same time is established in rural areas following the experience of SHOGORIP (*Storage* cum credit programme) that is likely to allow the farmers to store their produces and sell the same at better prices when the demand is high. Alternatively, government might encourage establishing farmers' cooperatives to ensure fair price of their produces. To make the cooperatives successful, traditional top-down approach must be avoided. The cooperatives should not be run as a

commercial profit-making entity. Formation of "Agricultural Prices Commission" by the government is also suggested for fixing the prices of farmers' produces.

2.9.6 Marketing facility

Marketing is defined as the process of determining the needs and wants of consumers and being able to deliver products that satisfy those needs and wants (Kotler, 2010). According to Cant (2010), marketing involves all of the activities that are necessary to move a product from the producer to the consumer. The activities include packaging, transport, processing, storage and lastly the retail sale of agricultural products. Marketing activities also include the planning, pricing, promotion and distribution of products (Agricultural Marketing Resource Center, 2007).

Abdullah and Hossain (2013) noted that agricultural marketing is an essential tool for uninterrupted, adequate and timely supply of agricultural products, inputs and services to target groups, including producers, consumers and intermediaries.

According to Baloyi (2010), farmers are faced with new challenges that include inconsistent supply of high quality produce, knowledge of acceptable agricultural practices, capacity to comply with market and regulatory requirements, and traceability.

Omiti *et al*. (2007), citing Pingali (1997), mentioned that improvements in market participation are necessary to link smallholder farmers to markets in order to set opportunities for income generation. However, there is doubt about the capability of smallholder farmers to participate effectively in the market due to their limited access to capital, infrastructure and extension services (Tshuma, 2014).

Storage is an important marketing function, which involves holding and preserving goods from the time they are produced until they are needed for consumption (Bhopal, 2004). In rural areas, storage facilities are usually non-existent (Jacob, 2008), which is one of the major constraints to farmers in rural areas (Omiti, 2007).

Good infrastructure is a requirement for achieving higher levels of agricultural productivity and profitability. Chaminuka *et al*. (2008), citing studies by Makhura and Wasike (2003) and Fan and Zhang (2004), mentioned that good infrastructural services are necessary for agriculture and rural development. It is believed that if business growth is to be realized, improvement in the supply and quality of

infrastructure services is essential. Business activities such as transportation of goods and storage depend upon infrastructural availability.

2.9.7 Adequacy of Extension Services

World Bank (2006) showed the importance of extension agent in a study. According to their study, the role of extension is very important to support sustainable agriculture.

Zhen et al. (2005) found in their study that most of the farmers are dissatisfied (50%) or even strongly dissatisfied (23%) with the present extension services and their agents. The lack of services, limited use of the services by the farmers, no participation of the farmers in general extension activities, an inadequate number of extension workers, the high commercial orientation of the services and the low working efficiency of the AEWs (Agricultural extension workers) are considered by the farmers as the major reasons for the ineffectiveness of the services.

Allahyari (2009) explained the importance of extension services in attaining sustainability. He stated that extension could play a key role in fostering sustainability through its educational programs but there has been a growing realization that traditional extension models have not been sufficiently effective in promoting adoption of sustainable agricultural practices.

2.9.8 Access to information

Business opportunities perceived by agribusiness entrepreneurs depend on the availability of information, the entrepreneur's perception of his or her management skills, and other factors (Mkhabela, 2005**)**.

According to Ruijis (2002), cited by Jari (2009), information on consumer preferences, quantity demanded, prices, produce quality, market requirements and opportunities is necessary. Access to such market information puts a farmer in a better position to make informed decisions. Farmers are able to make timely and better informed production and marketing decisions if they have full and easy access to reliable and up-to-date market information (Mabuza *et al.,* 2013). The lack of access to information puts smallholder farmers at a marketing disadvantage in that they may not know what commodities to produce, the relative quantities to produce, and the

most economical way to produce them with the resources available. In remote rural areas, the lack of reliable information is a major constraint (Omiti *et al.,* 2007).
Access to information among smallholders is generally poor and is compounded by the lack of reliable and efficient means of disseminating information (Jacobs, 2008).

2.9.9 Institutional function

Institutional constraints may arise directly or indirectly from a perceived lack of either government or private sector support (Clover and Darroch, 2005). In defining institutions, North (2000) states that institutions are the rules, norms and procedures that guide how people within societies live, work and interact with each other. Many of the services required to promote smallholder agricultural development are public goods. Therefore, little progress can be expected in achieving the objectives of agricultural development without government involvement (Machethe, 2004).

2.10 Conceptual model of the study

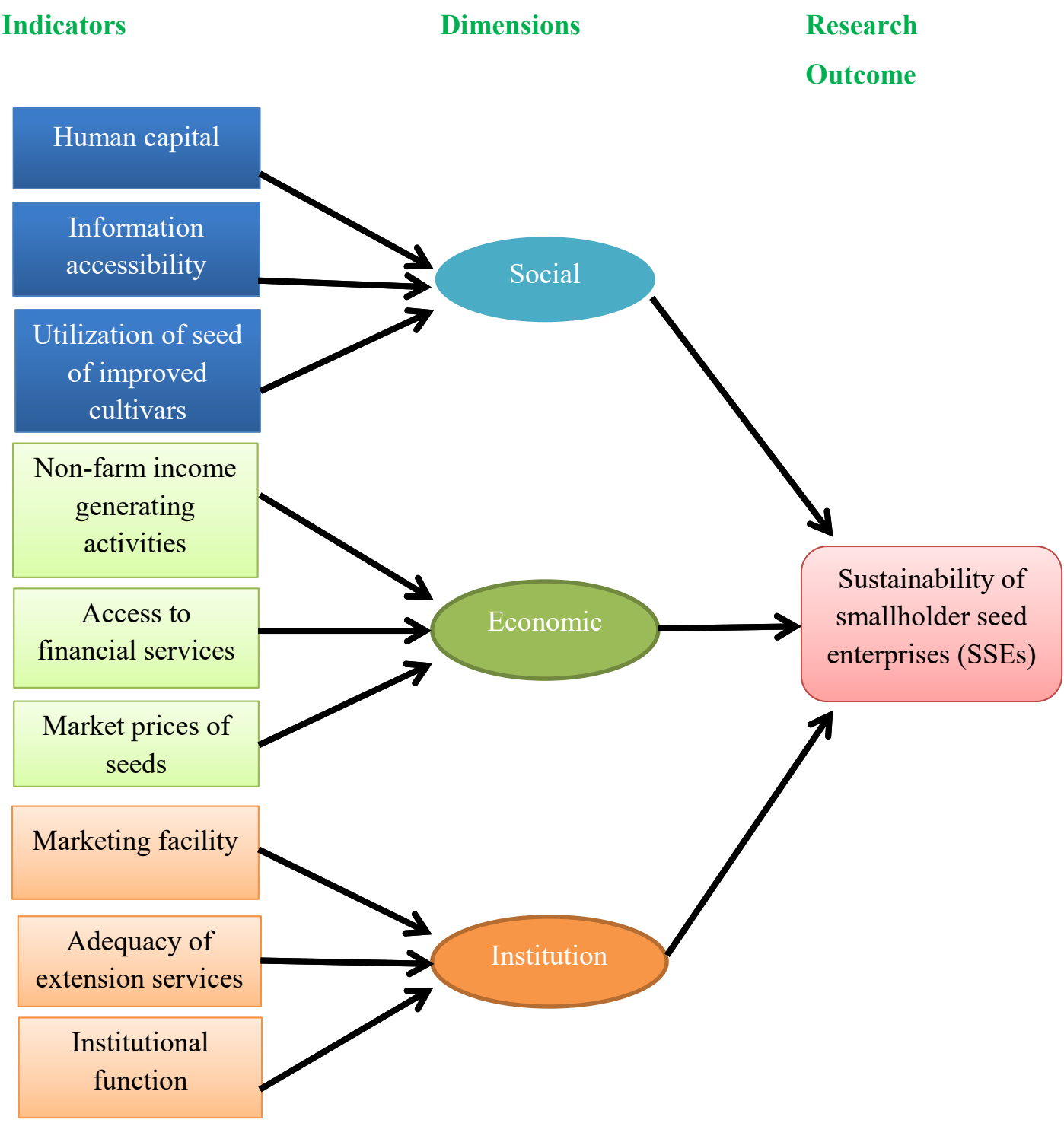

Fig. A conceptual model of smallholder seed enterprise

CHAPTER 3

RESEARCH METHODS

3.1 Introduction

This study is an empirical research on smallholder seed enterprises, using primary and secondary data and employing an array of tools such as composite indicator (CI). The method of data collection was farm household's survey. Secondary data on bio-physical, socio-economic conditions of seed growers and institutional information were collected from the Department of Agricultural Extension (DAE) and Bangladesh Bureau of Statistics (BBS). Secondary data were also gathered from relevant books, journals, governmental and NGO reports. The combination of methods was necessary to gain a broader and deeper understanding on smallholder seed systems. This chapter delineates the details of data collection as well as the construction procedure of CI.

3.2 Study location and Time

The research was conducted in six villages of Nagarpur and Shahjadpur upazila under Tangail and Shirajganj district respectively. Three villages from each upazila such as Ghiorkol, Danga Dhalapara, Danga Shalinapara under Nagarpur upazila and Bathiya purba para, Kaijuri, Narina under Shahjadpur upazila were purposively selected as the locale of the study are popular for agricultural seed production. The locales were also selected puposively as for the suitability of researcher to collect data. The data were collected on March and April, 2014. The map of Tangail and Shirajganj district have been presented in Figure 3.1 & 3.2 and specific study location have also been shown in Figure 3.3 & 3.4 respectively.

Figure 3.1 Map of Tangail District shows study area-Nagarpur upazila

Figure 3.2 Map of Shirajganj district shows study area-Shahjadpur upazila.

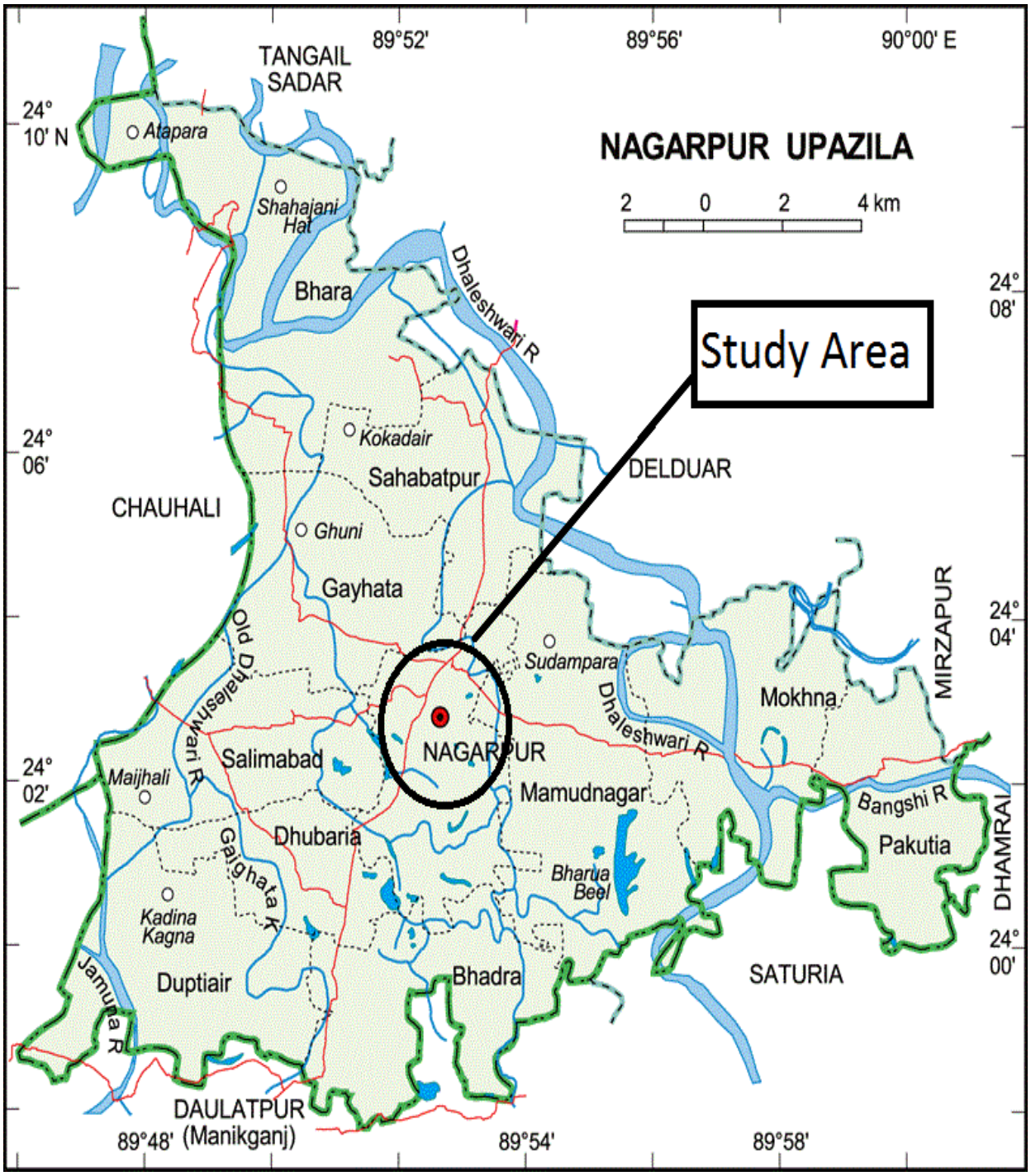

Figure 3.3 Map of Nagarpur upazila shows study area-Nagarpur sadar union

Figure 3.4 Map of Shahjadpur upazila shows study area.

3.3 Population and sample size

3.3.1 Determination of population size

Household heads in the selected villages of Nagarpur and Shahjadpur upazilas under Tangail and Shirajganj districts constituted the population of this study. Considering the time, financial resources and other constraints, data were collected from a sample rather than the entire population A total of 600 households were listed from 6 villages (Ghiorkol, Danga Dhalapara, Danga Shalinapara, Bathiya purbapara, Kaijuri, Narina) for household's survey purposively. However, representative sample from the population were taken for collection of data following random sampling technique. A random sampling procedure was followed to select one district from the whole of Bangladesh, and the same method was used to select the area of the district as well as the villages as the study group. Six hundred farmers constituted the population of this study which is shown in the following table 3.1.

3.3.2 Determination of sample size

There are several methods for determining the sample size; here, the study used Yamane's (1967) formula for study group:

$$n = \frac{z^2 P(1-P)N}{z^2 P(1-P) + N\,(e)^2}$$

Where,

n = Sample size;

N, population size = 600;

e, The level of precision = 8%;

z = the value of the standard normal variable given the chosen confidence level (e.g., z = 1.96 with a confidence level of 95 %) and

P, The proportion or degree of variability = 50%;

Here, the sample size (n) =120

3.3.3 Distribution of the population, sample size and reserve list

According to Yamane's formula, Sample size comprised of 120 farmers. Reserve list of 12 farmers (10% percent of the sample size) were also prepared so that the farmers of this list could be used for interview if the farmers included in the original sample were not available at the time of conduction of interview. The farmers of the villages were measured according to the proportionate of the total sample size (120) which was calculated using Yamane's (1967) formula. The distribution of the population, the number of sample size and number of respondents along with the reserve list are given in the following Table 3.1.

Table 3.1 Distribution of the rural farmers involved with different financial services according to population and reserve list

Name of the selected upazila	Name of the selected villages	Number of the household	Sample size	Reserve list
Nagarpur	Ghiorkol	97	19	2
	Danga Dhalapara	77	15	2
	Danga shalinapara	126	25	2
Shahjadpur	Bathiya purbapara	113	23	2
	Kaijuri	89	18	2
	Narina	98	20	2
	Total	600	120	12

3.4 Data collection methods and tools

3.4.1 Data collection methods

The survey method was used to collect quantitative data that allow to answer the research questions framed and to gain an understanding of the factors influence sustainability of smallholder seed enterprises. Individual interviews were used in the survey and were conducted in a face-to-face (Bryman, 2001) situation by the researcher. This method is useful to get unanticipated answers and to allow respondents to describe the world as they really see it rather than as the researcher

does (Bryman, 2001). Both quantitative and qualitative data were collected in connection with all the information needed to answer the research questions.

3.4.2 Data collection tools

A structured and different semi structured questionnaire with closed ended questions is prepared. The questions in this schedule were formulated in a simple and unambiguous way and arranged in a logical order to make it more attractive and comprehensive. The survey tools were initially constructed based on an extensive literature reviews and pre-tested. The schedule was pre-tested with 10 randomly selected farmers in the study area. The pre-test was helpful in identifying faulty questions and statements in the draft schedule. Thus, necessary additions, deletions, modifications and adjustments were made in the schedule on the basis of experiences gained from pre-test. Finally, based on background information, an expert appraisal and the pre-test, the interview schedule was finalized. One type of qualitative methods was used which was key Informant Interviews.

3.5 Variables and their measurement techniques

A research work usually contains at least two important variables viz. independent and dependent variables. An independent variable is that factor which is manipulated by the researcher in his attempt to ascertain its relationship to an observed phenomenon. A dependent variable is that factor which appears, disappears or varies as the researcher introduces, removes or varies the independent variable (Townsend, 1953). In the scientific research, the selection and measurement of variable constitute a significant task. Following this conception, the researcher reviewed literature (Roy and chan, 2015; FAO, 2015; Roy *et al*, 2014) to widen this understanding about the natures and scopes of the variables relevant to this research. Based on literature review, 9 variables were selected. The independent variables were: human capital, non-farm income generating activities, access to financial services, utilization of seed of improved cultivars, market prices of seeds, marketing facility, adequacy of extension services, information accessibility and institutional function. The definition, measurement, dimension and the categories of the variables are presented in the following Table 3.2

Table 3.2 Indicators definition & measurement, dimension and the categories

Dimensions & objectives	Indicators	Definitions and measurement
Social: to enhance the quality of life of the society at large	Human capital	Explores and measures farmer's knowledge, skills, and capacities for innovation in conventional and modern farming systems. For each category: 5 = 'definitely'; 4 = 'probably'; 3 = 'probably not'; 2 = 'not sure' and 1 = 'definitely not'. (Roy et al., 2013)
	Information accessibility	This indicator defines and measures availability and access to 12 sources of agricultural information to farmers. For availability: 1 = 'available'; and 0= 'not available'. For accessibility: 1 = 'accessible' and 0 = 'not accessible'. (Roy et al., 2015)
	Utilization of seed of improved cultivars	Indicates the adoption of modern seed varieties by the farmers. For 'yes'=1, 'no'=0 and 'low'=1, 'medium'=2, 'high'=3. For each crop species name 1 score has been added. (FAO, 2015)
Economic: to achieve economic viability	Non-farm income generating activities	Comprising all those activities that are not agricultural but generate income. 1 for 'yes' and 0 for 'no'. The non-farm activities that may contribute to the family income are counted from a list of activities to measure it. (FAO, 1998)
	Access to financial services	Ability of individuals or enterprises to obtain financial services. It is measured based on different financial sources. In this case, 2= "Sustained access",1=" Intermittent access" and 0="No access" (Roy et al., 2013)
	Market price of seeds	Measures the stability of the price of seeds in local market. For each category 0='too low',1= 'unpredictable', 2='fluctuating', 3='high'. (FAO, 2015)
Institution: to improve governance of the institutes	Marketing facility	Degree of market access for selling seeds and other agricultural inputs. It is measured based on the marketing infrastructure and suitability of buying and selling products. In this case, 0='not good at all', 1='not good', 2='no opinion', 4='good', 4='very good'. (FAO, 2015)
	Adequacy of extension services	This indicator is quantified by asking the extent of extension contact made by the farmers to personnel, and vice versa in the last year. 3 = '4 times and above'; 2 = '2–3 times'; 1 = 'one time'; and 0 = 'no visit'. (Zhen et al., 2005)
	Institutional function	Measures the extent of commitment, coordination and cooperation as functions of institutions. For each category 0='not at all', 1='not very much', 2='no opinion', 3='quite a lot', 4='a great deal'. (World Bank, 2017)

3.6 Construction of Composite Index (CI)

3.6.1 Sustainability assessment using CI

Sustainability is often described as a vague and heterogeneous concept, but its evaluation by using indicators is well established (Bell and Morse, 2004). CI is the mathematical combination of individual indicators based on an underlying model, taking methodological assumptions and subjective as well as objective judgements. CI is increasingly recognized as a useful tool for assessing environmental sustainability (Esty et al., 2005), policy analysis (Brand et al., 2007), good governance (Rotberg and Gisselquist, 2008), environmental performance (Emerson et al. 2010), and competitiveness (WEF, 2012). Bandura (2005) surveyed a comprehensive review of CI and reported a dramatic growth of CI in diverse fields. In the agricultural sector, CI has been used by many researchers employing different approaches (e.g. Rigby et al., 2001).

An impressive number of researchers and organizations reported the usefulness of CI for performance evaluation. For instance, CI is: (i) user friendly by reducing the plethora of information for easier decision making (Costanza, 2000), (ii) valuable as a communication and political tool (Freudenberg, 2003) (iii) good for providing detailed information (Sauvenier et al., 2005), (iv) effective in summarizing multidimensional issues and providing a big picture (Saisana et al., 2005), (v) innovative in evaluating the sustainability performance (Singh et al., 2007), (vi) helpful in setting policy priorities and benchmarking or monitoring performance (OECD, 2008), (vii) a powerful and communicative tool for planners (Gasparatos et al., 2008), and (viii) comprehensive regarding communication and interpretation (Kondyli, 2010).

3.6.2 Methodology employed for Indicators development and construction of CI

Freebairn and King (2003) have proposed an approach for the generation of indicators, illustrating the significance of key-players in the indicator development process. Many studies (Monroy-Ortiz et al. 2009) reported developing an indicator by adopting a participatory approach that was fit-for-purpose, integrative, and comprehensive in terms of the efficiency and effectiveness in formulating

sustainability-compatible development strategies. Moreover, expert-led indicator development with active participation of local stakeholders is recognized for consolidative assessment (Roy and Chan 2012). To start with, previous literature was reviewed and synthesized so as to obtain a potential set of indicators. The accuracy, reliability, and sensitivity of the indicators can be ensured through an iterative process of empirical (eg. expert opinion) and community (local leader, input dealers etc.) evaluation (Saisana *et al.,* 2005). The work of Roy et al. (2013) can be referred to for more methodological details. Figure 3.5 provides an illustration of the methodology employed for the construction of a composite indicator in study.

Step	Stage	Tool & method applied	Output
Step 5	Index construction	Correlation and path analysis	Generating a meaningful and communicative CI
Step 4	Normalization, weighting and aggregation	Max-min normalization factor analysis for weighting and linear aggregation	Making data comparable, assessing weight of indicators and combining them
Step 3	Data screening, bivariate and multivariate analysis	Estimating skewness, kurtosis, outlier checking, correlation	Ensuring quality and structure of the data set for subsequent methodological choices
Step 2	Conducting survey and data collection	Farm household's survey, checking and cross checking data	Preparing a complete data set
Step 1	Theoretical foundation and indicator development	Literature review, expert opinion, and focus group discussion	Developing a set of indicators

Figure 3.5 Construction methodology of a composite indicator (CI)

3.6.2.1 Maintaining data quality

A good quality data is essential for constructing a meaningful and communicative CI. Adequate cares were taken for maintaining data quality, which was accomplished in two ways, namely applying data-screening tests and bivariate and multivariate analysis to examine the overall structure and suitability of the data set for subsequent methodological choices. Data screening was employed to ensure the data are useful reliable and valid for testing causal theory. The validity, interpretability, and explanatory power of the index largely depend on the quality of underlying data. Data screening tests such as detecting missing data, removing outliers,estimating the data normality (eg. skewness, kurtosis) and identifying multicollinearity among the variables were conducted to ensure the data quality. Missing data were imputed by mean value substitution. Outlier has a strong impact on correlation structure and multivariate analysis. It needs particular care. The outliers were detected by observing z scores (>3.3) and graphing the data in a histogram. They were dealt by employing the next highest score plus one, and the mean plus two standard deviations (Field, 2009). Moreover, skewness and kurtosis were estimated to observe the normality of the variables, which is significant for employing regression analysis. The work of Field (2009) was followed for data-screening tests.

Multicollinearity ($r > 0.80$) between the indicators creates a considerable problem such as double-counting (i.e. two or more indicators measure the same behaviour). To fix this problem two ways are suggested in the literature: (i) to drop one of the variables from the analysis and (ii) the particular variables are simply averaged to produce a new variable (Field, 2009). Following data-screening tests, the correlation analysis was conducted to observe the interrelationships of the indicators. The results also indicated that multicollinearity was not a problem among the indicators.(see Appendix B)

3.6.2.2 Normalization of data

Generally, data of variables are incommensurate with each other, and has different measurement units. Therefore, normalization is a good way to make them comparable.

The method of normalization should be determined based on data properties and the aim of the index. OECD (2008) described several normalizations methods such as ranking, max-min, etc. By considering the pros (e.g. simple) and cons (e.g. outlier) of various methods into consideration, this study used max-min [Equation (1)].

$$li = \frac{x - \min(x)}{\max(x) - \min(x)} \qquad \text{.....(1)}$$

Where, *Ii* is the normalized value of the individual indicator, *x* is the raw value of individual indicator and *max (x)* and *min (x).*

3.6.2.3 Weighting & Aggregation

There is no consensus for the appropriate weighting method. Researchers are continuing to debate the suitable methods for weighting that reward greater weight of variables. There is a dichotomy between the participatory (subjective) and statistical (objective) method of weighting. A number of weighting methods exist. However, each method (e.g. budget allocation processes) has been reported to have limitations. Equal weighting (EW) is the most widely used method, and has the risk of double counting (by combining variables with high degree of correlation) and ignores the statistical and empirical basis, implying a judgment on the weights being equal (Nardo et al., 2005). Babbie (1995) reported equal weighting should be the standard and the application of other weighting method desires a proper justification. Researchers such as Hueting and Reijnders (2004), Munda (2005), Böhringer et al. (2007) criticized the participatory approaches of weighting for their arbitrary nature, as well as inherent lacking of statistical and empirical point of view. From the policy perspective, public opinion-based weighting has been established. Although it is a legitimate choice, it is not unique and its arbitrary characteristic raises criticism. These methods are justifiable only when there is a well-defined basis for national policy (Munda, 2007).

Despite CI being a subject of subjectivity, the use of objective method for calculating indicator weight is increasing progressively. The main reasons for using the objective or statistical methods are methodological soundness, transparency, impartiality, and thorough data-driven. When conceptualizing policy perspective, these methods are

inconsistent with the goal of CI (Munda, 2008), and the priorities of policy makers, who ultimately play the key role by investing on sustainable development. Realizing the suitability of the method, this study employed Equal weighting (EW) for weighting measurement. Indicators are simply summed and divided by the number of indicators. Assigning a weight of 2 (or 3) to one or more indicators implies that these indicators are twice (or three times) more important than indicators which retain a weighting of 1.

Aggregation influences compensation among variables (Munda, 2008). Therefore, it is a very delicate part of the construction of an index that needs particular care. A number of aggregation methods exist, and the choice of a suitable method depends on the purpose of CI and the nature of the subject being measured. Aggregation technique is strongly related to the method used to normalize the raw data (Nardo et al., 2005; OECD, 2008). The linear method is useful when indicators have the same measurement unit. Geometric aggregation is suitable when sub-indicators are non-comparable and have strictly positive value in ratio-scale of measurement. For aggregating individual indicators into composite indicators, the Vulnerability Sourcebook recommends a method called 'weighted arithmetic aggregation'. This is a common, simple and transparent aggregation procedure. Individual indicators are multiplied by their weights, summed and subsequently divided by the sum of their weights to calculate the composite indicator (CI), as indicated in the following,

$$CI = \frac{(I_1 * w_1 + I_2 * w_2 + \ldots In * w_n)}{\sum_{1}^{n} w}$$

Where, *CI* is the smallholder seed enterprise sustainability index, *I* is the normalized individual indicator, and *w* is the weight associated to individual indicator.

3.7 Statistical analysis

The analysis was performed using SPSS (Statistical Package for Social Sciences) computer package. Descriptive analyses such as range, number, percentage, mean, standard deviation were used whenever possible. Pearson's Product Moment Co-efficient of Correlation (r) was used in the order to explore the relationship between the concerned variables. Throughout the study, at least five percent (0.05) level of probability was used as basis of rejecting a null hypothesis.

Regression analysis was used to identify the linear combination between independent variables used collectively to predict the dependent variables. Regression analysis helps us understand how the typical value of the dependent variable changes when any one of the independent variables is varied, while the other independent variables are held fixed. The factors that contribute to the sustainable smallholder seed enterprise by the respondents are analyzed using a regression model. The overall quality of fit of the model has been tested by ANOVA specifically F and R^2 test.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

Findings and discussion is the central point of whole research work. The purpose of this chapter is to describe the findings of the study. In this chapter, the findings of the study and the interpretations of their meaning are presented. These are conveniently presented in three sections in accordance with the objectives of the study. In the first section the selected characteristics of the smallholder farmers have been discussed. The second section deals with the sustainability of smallholder seed enterprise. The third section deals with contribution of the respondent's selected characteristics to their sustainability of smallholder seed enterprise. The third section deals with the relationship among the sub-component of the sustainability of smallholder seed enterprises.

4.2 Indicators of the respondents

There were various indicators of the respondents that might have consequence to sustainable smallholder seed enterprises. But in this study, nine indicators of them were selected as independent variables, which included their human capital, non-farm income generating activities, access to financial services, utilization of seed of improved cultivars, market prices of the seeds, marketing facility, adequacy of extension services, information accessibility, institutional function that greatly influenced the sustainability of smallholder seed enterprises (based on literature review). A salient features that represent the sustainability of smallholder seed enterprises are presented in Table 4.1

Table 4.1 Salient features of the selected indicators

Characteristics	Value		Possible score	Skewness	kurtosis
	Min.	Max.			
Human capital	45	60	12-60	-0.122	-0.624
Non-farm income generating activities	2	6	0-11	0.796	0.926
Access to financial services	4	10	0-21	-0.328	0.217
Utilization of seed of improved cultivars	4	10	0-10	1.093	1.632
Market prices of the seeds	3	14	0-24	-0.147	-0.791
Marketing facility	11	24	0-28	0.164	-0.663
Adequacy of extension services	1	9	0-12	0.445	-0.264
Information accessibility	18	24	0-24	0.003	-0.457
Institutional function	12	29	0-36	0.197	-0.565

4.2.1 Human capital

Human capital score of the respondents ranged from 45 to 60 against possible score 12-60 with a mean and standard deviation of 53.31 and 3.35, respectively. Based on the human capital score, the respondents were classified into three categories (Mean ± Standard Deviation) namely ‘low’, ‘medium’ and ‘high’ human capital. The distribution of the respondents according to their human capital is presented in Table 4.2

Table 4.2 Distribution of the respondents according to their human capital

Category	Score		Respondent		Mean	SD
	Basis	Observed	Number	Percent		
Low human capital	≤ 49	45-60	17	14.2	53.31	3.35
Medium human capital	50-57		89	74.1		
High human capital	≥ 58		14	11.7		
Total			120	100		

Table 4.2 indicates that the highest proportion (74.1 percent) of the respondents had medium human capital compared to 14.2 percent in low human capital and the lowest 11.7 percent in high human capital category, respectively.

4.2.2 Non-farm income generating activities

The observed score of non-farm income of the respondents ranged from 2 to 6 score against possible score 0-11 with a mean and standard deviation of 3.03 and 0.87, respectively. On the basis of non-farm income, the respondents were classified into three categories (Mean ± Standard Deviation) namely 'low', 'medium' and 'high' non-farm income. The distribution of the respondents according to their non-farm income is presented in Table 4.3.

Table 4.3 Distribution of the respondents according to their non-farm income generating activities

Category	Score		Respondent		Mean	SD
	Basis	Observed	Number	Percent		
Low	≤ 2	2-6	35	29.2	3.03	0.87
Medium	3-4		80	66.6		
High	≥ 5		5	4.2		
Total			120	100		

Data revealed that the respondents having medium non-farm income constitute the highest proportion (66.6 percent), while the lowest proportion in high non-farm income (4.2 percent) and low income category constituted with 29.20 percent respondents. Overwhelming majority respondents involves in low to medium level non-farm income generating activities.

4.2.3 Access to financial services

The observed score of access to financial services of the respondents ranged from 4 to 10 against a possible range of 0 to 21. The average score of the respondent's needs of financial services was 7.45 with a standard deviation 1.35 (Table 4.4). The respondents were classified into three categories on the basis of their access to financial services, they were classified into three categories (Mean ± Standard Deviation) namely 'no access', 'intermittent access' and 'sustained access' of financial services of the respondents. Data showed that the highest proportion (85.8 %) of the respondents had intermittent access to financial services and no access to financial services was 7.53 percent of them and 6.67 percent fell in sustained access of financial services.

Table 4.4 Distribution of the respondents according to their access to financial services

Category	Score		Respondent		Mean	SD
	Basis	Observed	Number	Percent		
No access	≤ 5	4-10	9	7.53	7.45	1.35
Intermittent access	6-9		103	85.8		
Sustained access	≥ 7		8	6.67		
Total			120	100		

From this (Table 4.4), it might be concluded that majority of the respondents had intermittent access of financial services.

4.2.4 Utilization of seed of improved cultivars

The utilization of seed of improved cultivars scores of the farmers ranged from 4 to 10 with an average of 5.73 and standard deviation 1.29. The possible score of utilization of seed of improved cultivars is 0-10. Based on the utilization of seed of improved cultivars score, the respondents were classified into three categories (Mean ± Standard Deviation) namely 'low', 'medium' and 'high' utilization of seed of improved cultivars. Data in Table 4.5 reveal that the highest proportion 77.5 percent of the respondents fell into category and 15 percent had medium utilization category regarding utilization of seed of improved cultivars. 7.5 percent fell into high utilization category. The mean value (5.73) clearly indicates that respondents tend to low to medium utilization of seed of the improved cultivars.

Table 4.5 Distribution of the respondents according to their utilization of seed of improved cultivars

Category	Score		Respondent		Mean	SD
	Basis	Observed	Number	Percent		
Low	≤ 4	4-10	18	15	5.73	1.29
Medium	5-7		93	77.5		
High	≥ 8		9	7.5		
Total			120	100		

4.2.5 Market prices of the seeds

Market prices of the seeds of the respondents ranged from 3 to 14 against possible score of 0 to 24. The average score and standard deviation were 8.23 and 2.84, respectively. Based on the market price scores, the respondents were classified into three categories (Mean ± Standard Deviation) namely low, fluctuating and high market price.

Table 4.6 Distribution of the respondents according to their market prices of the seeds

Category	Score		Respondent		Mean	SD
	Basis	Observed	Number	Percent		
Low	≤ 4	3-14	17	14.2	8.23	2.84
Fluctuating	5-11		88	73.3		
High	≥ 12		15	12.5		
Total			120	100		

Table 4.6 reveals that 73.3 percent of the respondents had faced fluctuating market prices of seeds, 14.2 percent had low market price and 12.5 percent had high market price. Thus, an overwhelming majority (87.5 percent) of the respondents had faced low to fluctuating market prices of seeds.

4.2.6 Marketing facility

Marketing facility scores of the respondents ranged from 11 to 24 against possible score of 0 to 28. The average score and standard deviation were 17.06 and 3.25, respectively. Based on the marketing facility scores, the respondents were classified into three categories (Mean ± Standard Deviation) namely poor, moderate and developed marketing facility.

Table 4.7 Distribution of the respondents according to their marketing facility

Category	Score		Respondent		Mean	SD
	Basis	Observed	Number	Percent		
Poor	≤ 13	11-24	18	15	17.06	3.25
Moderate	14-20		82	68.3		
Developed	≥ 21		20	16.7		
Total			120	100		

Table 4.7 reveals that 68.3 percent of the respondents had moderate marketing facility, 15 percent had poor marketing facility and 16.7 percent had developed marketing

facility. Thus, an overwhelming majority (85 percent) of the respondents had moderate to developed marketing facility.

4.2.7 Adequacy of extension services

The observed score of contact with extension agents of the respondents ranged from 1 to 9 against a possible range of 0 to 12. The average score of the respondents' contact with extension agents was 3.69 with a standard deviation 1.75 (Table 4.8). The respondents were classified into three categories on the basis of their contact with extension agents scores and distribution of the three categories (Mean ± Standard Deviation) namely 'no visit', 'intermittent visit' and 'frequent visit' of the respondents. Data showed that the highest proportion (85.8 percent) of the respondents had intermittent contact and no contact with the extension agents was 9.2 percent and 5 percent fell in frequent contact with extension agents.

Table 4.8 Distribution of the respondents according to their adequacy of extension services

Category	Score		Respondent		Mean	SD
	Basis	Observed	Number	Percent		
No visit	≤ 1	1-9	11	9.2	3.69	1.75
Intermittent visit	2-6		103	85.8		
Frequent visit	≥ 7		6	5		
Total			120	100		

From this Table 4.8, it might be said that majority of the respondents had no contact to intermittent contact with extension agents. It could be stated that extension agent or media of the study area were available to the respondents. Finding reveals that 9.2 percent of the respondents had no extension organization contact which is indicating the improvement of the communication strategy. No extension contact might be the reason that some respondent may think that they have enough knowledge. This results in cognitive change of the users with an eventual change in behavior and also in skill.

They receive information from their neighbors, relatives and workmates etc. at the study area.

4.2.8 Information accessibility

Information access scores of the respondents ranged from 18 to 24 against possible score of 0 to 24. The average score and standard deviation were 21.32 and 1.46, respectively. Based on the Information access scores, the respondents were classified into three categories (Mean ± Standard Deviation) namely low, medium and high Information access.

Table 4.9 Distribution of the respondents according to their information accessibility

Category	Score		Respondent		Mean	SD
	Basis	Observed	Number	Percent		
Low access	≤ 19	18-24	12	10	21.32	1.46
Medium access	20-22		97	80.8		
High access	≥ 23		11	9.2		
Total			120	100		

Table 4.9 reveals that 80.8 percent of the respondents had medium Information accessibility, 10 percent had low Information accessibility and the lowest 9.2 percent had high Information accessibility.

4.2.9 Institutional function

Institutional function score of the respondents ranged from 12 to 29 with a mean and standard deviation of 19.78 and 4.1, respectively. The possible against observed score of institutional function is ranged from 0-36. Based on institutional function score, the respondents were classified into three categories (Mean ± Standard Deviation) namely less effective, medium effective and highly effective institutional function score. The distribution of the respondents as per their institutional function score is presented in Table 4.10.

Table 4.10 Distribution of the respondents according to their institutional function

Category	Score		Respondent		Mean	SD
	Basis	Observed	Number	Percent		
Less effective	≤ 15	12-29	20	16.7	19.78	4.1
Medium effective	16-24		83	69.1		
Highly effective	≥ 25		17	14.2		
Total			120	100		

Data reveals that the highest proportion (69.1 percent) of the respondents had medium effective in institutional function, while 16.7 percent had less effective in institutional function and the lowest 14.2 percent had highly effective in institutional function. It might be logical because the respondents of the study area were suppressed by some political barrier.

4.3 Sustainability of smallholder seed enterprise

Sustainability of smallholder seed enterprise scores of the respondents ranged from 27.01 to 64.08. The average score and standard deviation were 48.98 and 8.05 respectively. Based on the sustainability of smallholder seed enterprises scores, the respondents were classified into four categories namely not sustainable, moderately sustainable, reasonably sustainable and highly sustainable to rural financial services. This following categorization is based on the Royal London (2017).

Table 4.11 Distribution of the respondents according to their sustainable smallholder seed enterprises

Category	Score		Respondent		Mean	SD
	Basis	Observed	Number	Percent		
Not sustainable	≤ 36.27	27.01-64.08	9	7.5	48.98	8.05
Moderately sustainable	36.28-45.54		28	23.3		
Reasonably sustainable	45.55-54.81		53	44.2		
Highly sustainable	≥ 54.82		30	25		
Total			120	100		

Table 4.11 reveals that 44.2 percent of the respondents had reasonably sustainable to smallholder seed enterprise, 23.3 percent had moderately sustainable to smallholder seed enterprise, 25 percent had highly sustainable to smallholder seed enterprise and the lowest 7.5 percent had not sustainable to smallholder seed enterprise. Thus, an overwhelming majority (92.5 percent) of the respondents had moderately to highly sustainable to smallholder seed enterprise.

4.4 Correlation between sustainability index and some important indicators

A couple correlation result is presented in Appendix B.

i. A coefficient of r=.574 indicates that the two variables, namely, 'institutional function' and 'sustainability index' are strongly and positively correlated, so as effectiveness of institutional function increases, sustainability of smallholder seed enterprises increases by a proportionate amount.

ii. A coefficient of r =.395, indicates that the 'market prices of seeds' and 'sustainability index' have positive and moderately significant relationships, so as market prices of seeds increases, the sustainability of smallholder seed enterprises increases by a proportionate amount.

iii. From Table 4.12, it can be showed that non-farm income generating activities is negatively correlated to sustainability index, with a coefficient of *r*= -.128,

which is non-significant both at $p < .01$ and $p<.05$. This coefficient value indicates as the number of non-farm income generating activities decreases, sustainability of smallholder seed enterprises increases.

Table 4.12 Correlation between sustainability index and important indicators

Indicators	Sustainability Index
Institutional function	.574**
Market prices of seeds	.395**
Information accessibility	.360**
Market facility	.320**
Adequacy of extension services	.319**
Utilization of seeds of improved cultivars	.317**
Human Capital	.284**
Non-farm income generating activities	-.128

4.5 Relationship between sustainability index and its dimensions

To justify the conceptualization of sustainability of smallholder seed enterprises, the inter relationships among their selected dimensions were shown in the Table 4.13.

Table 4.13 Coefficient of correlation of the dimensions of sustainability index

	Dimensions		
	Social	Economic	Institution
Sustainability Index	.475**	.283**	.654**
Dimensions			
Social	1	.113**	.350**
Economic	.113**	1	.025**
Institution	.350**	.025**	1

** Correlation is significant at the 0.01 level (2-tailed).

4.5.1 Relationship between sustainability index and institution dimension

Table 4.13 shows that effectiveness of institution is strongly and positively correlated to sustainability index, with a coefficient of r =.654, which is significant at $p < .01$. This coefficient value indicates as the strengthening of effectiveness of institution increases, sustainability of smallholder seed enterprises increases.

4.5.2 Relationship between sustainability index and social dimension

A coefficient of r =.475 indicates that social dimension of sustainability and sustainability index are strongly and positively correlated, so as development of social aspects of smallholder farmer increases, sustainability of smallholder seed enterprises increases by a proportionate amount.

4.5.3 Relationship between sustainability index and economic dimension

A coefficient of r =.283 indicates that economic dimension of sustainability and sustainability index are moderately and positively correlated, so as promoting economic sustainability of smallholder farmer, sustainability of smallholder seed enterprises can be increased by a proportionate amount.

4.6 Factors affecting the sustainability of smallholder seed enterprises

In order to assessment of sustainability of smallholder seed enterprises from the composite sustainability indicators, multiple regression analysis were used which is shown in the Table 4.14, 4.15 and 4.16.

Table 4.14 Model Summary of the multiple regression done in the study

Model	R	R Square	Adjusted R square	Std. Error of the Estimate
1	.847	.718	.687	5.17596

Table 4.15 ANOVA of the multiple regression done in the study

Model	Sum of Squares	df	Mean square	F	Sig.
Regression	4770.291	9	530.032	19.784	.000
Residual	2946.963	110	26.791		
Total	7717.253	119			

Table 4.16 Multiple regression coefficients of contributing factors affecting sustainability of smallholder seed enterprises

Developed variables	Indicators	Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error		
Composite Sustainability Indicator	Human capital	.648	.157	.285	.000**
	Non-farm income generating activities	.153	.611	.017	.802
	Access to financial services	.645	.365	.108	.080*
	Utilization of seed of improved cultivars	.047	.429	.008	.913
	Market prices of the seeds	.912	.191	.322	.000**
	Marketing facility	.584	.165	236	.001**
	Adequacy of extension services	.590	.322	.129	.070*
	Information accessibility	.714	.356	.130	.047*
	Institutional function	.781	.128	.399	.000**

** Significant at $p < 0.01$;

* Significant at $p < 0.05$;

4.6.1 Interpretation of the tables of multiple regression analysis

4.6.1.1 Interpretation of model summary

This model summary table 4.14 provides the value of R and R^2 for the model that has been derived. For these data, R has a value of .847 represents the simple correlation between selected variables and smallholder seed enterprises sustainability. The value of R^2 is .718, which tells us that the selected variables can account for 72% of sustainability of smallholder seed enterprises. There might be many factors that can explain the sustainability, but this model, which includes a sustainability index, which can explain approximately 72% of it. This means that 28% of the sustainability of smallholder seed enterprises cannot be explained by selected variables. Therefore, there must be other variables that have an influence also.

4.6.1.2 Interpretation of ANOVA table

The ANOVA tells us whether the results in a significantly good degree of prediction of the outcome variable or not. The most important part of the table is the F-ratio, and the associated significance value of that F-ratio. From the table 4.15, the value of F-ratio is 19.784, which is significant at $p < .001$ (because the value in the column labeled Sig. is less than .001). However, the ANOVA doesn't tell us about the individual contribution of variables in the model.

4.6.1.3 Interpretation of coefficient table

In general, values of the regression coefficient B represent the change in the outcome resulting from a unit change in the predictor and that if a predictor is having a significant impact on our ability to predict the outcome then this B should be different from 0. The beta coefficients can be negative or positive, and have a t-value and significance of that *t*-value associated with each. If the beta coefficient is not statistically significant (i.e., the *t*-value is not significant), no statistical significance can be interpreted from that predictor.

Table 4.16 shows that the significant indicators are human capital, access to financial services, market prices of the seeds, marketing facility, adequacy of extension

services, information accessibility and institutional functions. Of these, human capital, market prices of seeds, marketing facility and institutional function were most contributing factors (significant at 1% level of significance) while access to financial services, adequacy of extension services and information accessibility are significant at 5% level of significance.

Institutional function (*b*= .399): This value indicates that as institutional function increases by one standard deviation, smallholder seed enterprises sustainability increases by 0.781 standard deviations. This interpretation is true only if the effects of other variables are held constant.

Market prices of seeds (*b*= .322): This value indicates that as market prices of seeds increases by one standard deviation, smallholder seed enterprises sustainability increases by 0.912 standard deviations. This interpretation is true only if the effects of other variables are held constant.

Human capital (*b* = .285): This value indicates that as human capital increases by one standard deviation, smallholder seed enterprises sustainability increases by 0.648 standard deviations. This interpretation is true only if the effects of variables are held constant.

Marketing facility (*b* = .236): This value indicates that as institutional function increases by standard deviation, smallholder seed enterprises sustainability increases by 0.584 standard deviations. This interpretation is true only if the effects of other variables are held constant.

So, most contributing factors of sustainability of smallholder seed enterprises were institutional function, market prices of seeds, human capital and marketing facility. It is therefore, can be said that sustainability of smallholder seed enterprises can be improved by investing on institutional function, market prices of seeds, human capital and marketing facility of smallholder farmers.

4.7 Policy Implications

The findings of the study have significant policy implications for smallholder seed producers, which are essential for agricultural development. As per the findings of this study, policies should also pay due attention to address the major constraints of

smallholder seed enterprises. Therefore, the following overall policy implications were drawn with rationale and practical reference for attaining sustainable smallholder seed enterprises in Bangladesh. These policies are based on four major factors (institutional function, human capital, market prices of seeds, marketing facility) those have most impact on sustainable smallholder seed enterprises.

- Strengthening coordination among the government and the smallholder seed growers

Government needs to guide and manage seed system including extension services, low input prices, subsidized services, agricultural risk management, seed marketing polices etc. to encourage smallholder farmers for actively participating in farm level seed production. Government policies should aim to ensure availability of credit both to seed enterprises and to farmers for purchase of seed.

- Maintaining selling prices of the seeds in the local markets

There is a tendency for the farmers to not produce seeds due to low or fluctuated market price. Moreover, high price of inputs and lack of storage facilities were discouraged them to produce more seeds. Measures should therefore be taken to maintain stable and profitable seed selling prices so that more smallholders come forward to contribute to the commercial seed enterprise.

- Improve farmer's knowledge, skill, and capacity development to enable and prepare them to face the challenges of the twenty-first century.

In Bangladesh, farmers face enormous challenges of shortage of natural resources (BARC 2011). More investment is needed to improve the ability of smallholders for best seed cultivation, processing, storage, development and marketing. The farmers' homegrown seed are sometimes inferior in quality compared to certified seed due to farmers' insufficient knowledge on seed production systems. Improving farmers' skills and knowledge in seed storage, seed quality management, marketing should be enhanced by facilitating improved practices. This study also found that agricultural

extension services and modern information systems can play a central role in farmer's capacity building. It will keep the smallholder seed enterprise commercially viable.

- Providing adequate marketing facility and developing infrastructures

Smallholder farmers face some problems such as lack of established market, unavailability of local transport, government monitoring and intervention of middle man in the local market while selling their agricultural goods. Poor marketing infrastructure, particularly processing and storage facilities, was a major constraint for farm level seed production. Governments should consider providing subsidies or other related support and services for establishing seed enterprise infrastructure, especially in the early stages of development of the seed sector.

CHAPTER 5

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

Smallholder farming is getting priority in the developing world in general and Bangladesh in particular. This prioritization of smallholder farming has been reflected in the policy agenda of many developing countries. In Bangladesh, smallholder farmers cultivate approximate to 95% of the total cropped land and produce more than 90% of the total agricultural output. Given the agricultural led industrialization strategy for development and the dominance of smallholder agriculture in Bangladesh, it becomes imperative that smallholder farmers be transformed from the subsistence based production to market oriented production system. However, the degree of agricultural commercialization is at its infant stage in Bangladesh which is given by the national average of 33 to 36% in 2014.

5.1 Major findings

5.1.1 Selected characteristics of the respondents

Human capital

The highest proportion (74.1 percent) of the respondents had medium human capital compared to 14.2 percent in low human capital and the lowest 11.7 percent in high human capital category, respectively

Non-farm income generating activities

The respondents having medium non-farm income constitute the highest proportion (66.6 percent), while the lowest proportion in high non-farm income (4.2 percent) and low income category constituted with 29.20 percent respondents. Overwhelming majority respondents involves in low to medium level non-farm income generating activities.

Access to financial services

As most of the smallholder farmers are poor and have low number of non-farm income generating activities, majority of them had intermittent access of financial services.

Utilization of seed of improved cultivars

The highest proportion 77.5 percent of the respondents fell into category and 15 percent had medium utilization category regarding utilization of seed of improved cultivars. 7.5 percent fell into high utilization category. The mean value (5.73) clearly indicates that respondents tend to low to medium utilization of seed of the improved cultivars.

Market prices of the seeds

The highest proportion 73.3 percent of the respondents had faced fluctuating market prices of seeds, 14.2 percent had low market price and 12.5 percent had high market price. Thus, an overwhelming majority (87.5 percent) of the respondents had faced low to fluctuating market prices of seeds.

Marketing facility

The highest proportion 68.3 percent of the respondents had moderate marketing facility, 15 percent had poor marketing facility and 16.7 percent had developed marketing facility. Thus, an overwhelming majority (85 percent) of the respondents had moderate to developed marketing facility.

Adequacy of extension services

It might be said that majority of the respondents had no contact to intermittent contact with extension agents. It could be stated that extension agent or media of the study area were available to the respondents. Finding reveals that 9.2 percent of the respondents had no extension organization contact which is indicating the improvement of the communication strategy. No extension contact might be the reason that some respondent may think that they have enough knowledge. This results in cognitive change of the users with an eventual change in behavior and also in skill. They receive information from their neighbors, relatives and workmates etc. at the study area.

Information accessibility

The highest proportion 80.8 percent of the respondents had medium Information accessibility, 10 percent had low Information accessibility and the lowest 9.2 percent had high Information accessibility.

Institutional function

The highest proportion (69.1 percent) of the respondents had medium effective in institutional function, while 16.7 percent had less effective in institutional function and the lowest 14.2 percent had highly effective in institutional function. It might be logical because the respondents of the study area were suppressed by some political barrier.

5.1.2 Sustainability of smallholder seed enterprises

The highest proportion 44.2 percent of the respondents had reasonably sustainable to smallholder seed enterprise, 23.3 percent had moderately sustainable to smallholder seed enterprise, 25 percent had highly sustainable to smallholder seed enterprise and the lowest 7.5 percent had not sustainable to smallholder seed enterprise. Thus, an overwhelming majority (92.5 percent) of the respondents had moderately to highly sustainable to smallholder seed enterprise.

5.1.3 Relationship between sustainability of smallholder seed enterprises index, dimensions and indicators

1. Social dimension and sustainability of smallholder seed enterprises index are strongly and positively correlated, so as development of social aspects of smallholder farmer increases, sustainability of smallholder seed enterprises promotes by a proportionate amount.
2. Economic dimension and sustainability of smallholder seed enterprises index are moderately and positively correlated, so as promoting economic sustainability of smallholder farmer, sustainability of smallholder seed enterprises can be promotes by a proportionate amount.
3. Effectiveness of institution is strongly and positively correlated to sustainability of smallholder seed enterprises.

4. Institutional function and sustainability of smallholder seed enterprises index are strongly and positively correlated, so as effectiveness of institutional functions increases, sustainability of smallholder seed enterprises increases by a proportionate amount.
5. Marketing prices of seeds strongly and positively correlated with sustainability of smallholder seed enterprises index. If market prices of seeds can be increased up to the smallholders' demand level, sustainability of smallholder seed enterprises will be promoted.

5.1.4 Factors affecting the sustainability of smallholder seed enterprises

Four variables, namely 'institutional function', 'market prices of seeds', 'human capital' and marketing facility' had contributed more into the regression model. The model, consisting of nine variables, explained 72% of the variation in the degree of the index.

5.2 Conclusions

I. Majority (92.5 percent) of the respondents had moderately to highly sustainable to smallholder seed enterprises.
II. The highest proportion (69.1 percent) of the respondents had medium effective in institutional function, while 16.7 percent had less effective in institutional function and the lowest 14.2 percent had highly effective in institutional function.
III. Findings reveal that majority (87.5 percent) of the respondents had faced low to fluctuating market prices of seeds.
IV. The highest proportion (74.1 percent) of the respondents had medium human capital compared to 14.2 percent in low human capital and the lowest 11.7 percent in high human capital category.
V. The finding shows that majority (85 percent) of the respondents had moderate to develop marketing facility.

VI. In the result of dimension level of sustainability, highest result obtained from institution dimension (.654) which means that institutional factors contribute the highest for smallholder seed enterprises sustainability.

VII. Multiple regression model shows that most contributing factors of sustainable smallholder farming were institutional function, market prices of seeds, human capital and marketing facility. It is therefore, can be said that sustainability of smallholder seed enterprises can be improved by investing on institutional function, market prices of seeds, human capital and marketing facility.

5.3 Recommendations

5.3.1 Recommendations for policy implications

- Strengthening of coordination among the government and the smallholder seed growers
- Maintenance of selling prices of the seeds in the local markets
- Improvement of farmer's knowledge, skill, and capacity development to enable and prepare them to face the challenges of the twenty-first century.
- Providing of adequate marketing facility and developing infrastructures

5.3.2 Recommendations for further study

I. The present study was conducted in Nagarpur and Shahjadpur upazilas under Tangail and Shirajganj district respectively. It is recommended that similar studies should be conducted in other areas of Bangladesh.

II. This study investigated the contribution of nine characteristics of the respondents with their sustainability of smallholder seed enterprises as dependent variables. Therefore, it is recommended that further study should be conducted with other characteristics of the respondents with the sustainability of smallholder seed enterprises.

III. Studies need to be undertaken to ascertain the principles and procedures for installation and patronization of nursing organization in the rural areas of Bangladesh.

IV. The study was based on the respondents' sustainability of smallholder seed enterprises. Further studies may be conducted in respect of other related issues.

V. How to solve the problem of unsustainable smallholder seed enterprises is an important factor on which researchers can conduct some research in order to contribute to solving the problem of poor accessibility seeds among smallholder farmers.

References

Abdullah, Md. and Hossain M.R., 2013. A new cooperative marketing strategy for agricultural products in Bangladesh. *World Review of Business Research*, 3(3), pp.130-144.

Allahyari, M.S. 2009. Agricultural sustainability: Implications for extension systems. College of Agriculture, Islamic Azad University, Rasht Branch, Rasht, Iran.

Almekinders, C. J. M. 2001. *Support for the informal seed sector in development cooperation: Conceptual issues*. Eschborn, Germany: Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH.

Almekinders, C.J.M., and Louwaars, N.P. (1999). *Farmers' seed production*. London: Intermediate Technology Publications Ltd.

Almekinders, C.J.M., Louwaars, N.P., and de Bruijin, G.H. (1994). Local seed systems and their importance for an improved seed supply in developing countries. *Euphytica* 78:207-16.

Anonymous. 2007. Asian Seed Congress, Manila, Philippines.

Babbie, E. (1995). The Practice of Social Research. Wadsworth, Washington, pp. 161–175.

Babu, S. and Sanyal, P. (2010). Capacity Strengthening for Agricultural Policy Analysis and Research in Nigeria-A Roadmap towards a Strategy Report No. NSSP 006. Nigeria, February 2010.4pp.

Bal, S. S., and J. E. Douglas. 1992. *Designing successful farmer-managed seed systems*. Development Studies Paper Series . Winrock, Arlington, United States: Winrock International Institute for Agricultural Development

Baloyi, J.K., 2010. An analysis of constraints facing smallholder farmers in the agribusiness value chain: A case study of farmers in the Limpompo Province. Unpublished thesis (M ins Agrar Agricultural Economics). Department of Agricultural Economics, Extension and Rural Development, Faculty of Natural and Agricultural Science, University of Pretoria, Pretoria.

Bandura, R. (2005). Measuring country performance and state behaviour: a survey of composite indices, UNDP/ODS Background Paper.

Bangladesh Agricultural Research Council (BARC). (2011). Agricultural research vision 2030 and beyond: Research priorities in Bangladesh agriculture, final draft. In G. Hussain, & A. Iqbal (Eds.), Dhaka: Government of Bangladesh (GoB).

BBS, Statistical Yearbook of Bangladesh. 2007. Bangladesh Bureau of Statistics (BBS).

Bell, S. and Morse, S. (2004). Experiences with sustainability indicators and stakeholder participation: a case study relating to a 'Blue Plan' project in Malta. Sustain. Dev., 12, 1-14

Bengtsson, F. 2007. Review of Information Available on Seed Security and Seed Aid Interventions in Ethiopia, Eritrea, Mali and Sudan. DCG Report No. 51. Drylands Coordination Group, Oslo, Norway. Available from: http://www.drylands-group.org/ Articles/1323.html (accessed 24 November 2009).

Betre, A. (2006). *Geography of Small-Holders' Commercialization: the Case of food grains in Ethiopia*. Paper submitted for Ethiopia Strategy Support Program (ESSP) Policy Conference 2006, IFPRI and EDRI, 6-8 June 2006, Addis Ababa, Ethiopia.

Böhringer, C., Patrick, E.P. and Jochem, P.E.P. (2007). Measuring the immeasurable- A survey of sustainability indices. Ecological Economics, 63, 1-8.

Brand, D.A., Saisana, M., Rynn L.A., Pennoni F., Lowenfels A.B. (2007). Comparative analysis of alcohol control policies in 30 Countries. PLoS Medicine, 4, 752-759.

Bryman, A. (2001). Social Research Methods. *Oxford: Oxford University Press*.

Cant, M. 2010. 1st Juta & Co. Ltd. Agricultural Marketing Resource Center, 2007. Lession 3: Direct Marketing of Agriculture produce.

Carletto, G., Covarrubias, K. and Rezza. A. 2007. Rural income generating activities in developing countries: re-assessing the evidence. FAO. Vol. 4, No. 1, 2007, pp. 146-193.

CGRFA (2011). Strengthening Seed System: *Gap analysis of the seed sector. Thirteenth Regular Session Rome*, 18-22, July, 2011. 9pp.

Chamberlin, J. (2008). *It's a Small World After All: Defining Smallholder Agriculture in Ghana*. IFPRI Discussion Paper No. 00823, November 2008.

Chaminuka, P., Senyolo, G.M., Makhura, M., and Belete, A., (2008). Service infrastructure and emerging farmers in South Africa: a factor analysis approach. *Agrekon* 47 (3), pp. 365-378.

Clover, T.A., and Darroch, M., 2005. Owners perceptions of factors that constrain the survival and growth of small, medium and micro agribusinesses in Kwazulu-Natal, South Africa. *Agrekon* 44 (2), pp. 238-263.

Costanza, R. (2000). The dynamics of the ecological footprint concept. Ecological Economics, 32, 341–345.

Davis, J. (2004) *The Rural Non-Farm Economy, Livelihoods and their Diversification: Issues and Options* Chatham, UK: Natural Resource Institute.

De Groote, H., C.Doss, S.D Lyimo, and W.Mwangi. 2002. *Adoption of maize technologies in East Africa - What happened to Africa's emerging maize revolution?* Paper prepared for the FASID Forum V, "Green revolution in Asia and its transferability to Africa", Tokyo, December 8-10, 2002.

Emerson, J., Esty, D.C., Levy, M.A., Kim, C.H., Mara, V., de Sherbinin, A. and Rebotnjak, T. (2010). Environmental Performance Index 2010. New Haven: Yale Centre for Environmental Law and Policy.

Esty, D.C., Levy, M., Srebotnjak, T., de Sherbinin, A. (2005). 2005 Environmental Sustainability Index: Benchmarking National Environmental Stewardship. New Haven: Yale Centre for Environmental Law & Policy.

Fan, S., and Zhang, X., 2004. Infrastructure and regional economic development in China. *China Economic Review* 15, pp. 203-214.

FAO (2009). Promoting the Growth and Development of Smallholder Seed Enterprises for Food Security Crops: *Best Practices and Options for Decision Making*. FAO Plant Production and Protection Paper Case studies from Brazil, Côte d‟Ivoire and India.24pp.

FAO, (2015). Self evaluation and holistic assessment of climate resilience of farmers and pastoralists. FAO, Italy: pp.166.

FAO, (2010). Promoting the Growth and Development of Smallholder Seed Enterprises for Food Security Crops. FAO, Italy.

FAO. 2004. *Toward effective and sustainable seed relief activities.* Plant Production and Protection Paper No. 181. Rome: FAO.

FAO, 1999. Seed policy and programmers for SSA. Food and Agricultural Organization of the United Nations, Rome, Italy.

FAO (1998), the State of Food and Agriculture: Rural Non-Farm Income in Developing Countries. Rome: Food and Agriculture Organization.

Fenwick, L.J., and Lyne, M.C., 1998. Factors influencing internal and external credit rationing among small-scale farm households in Kwazulu-Natal. *Agrekon,* 37 (4), pp. 495-505.

Freebairn, D.M. and King, C.A. (2003). Reflections on collectively working toward sustainability: Indicators for indicators! *Australian Journal of Experimental Agriculture*, 43: 223–238.

Freudenberg, M., (2003). Composite indicators of country performance: a critical assessment, OECD Science, Technology and Industry Working Papers, 2003/16, OECD Publishing.

Gasparatos, A., El-Haram, M., Horner, M. (2008). A critical review of reductionist approaches for assessing the progress towards sustainability. Environmental Impact Assessment Review, 28, 286–311.

Harris, Jonathan M., Timothy A Wise, Kevin P. Gallagher, and Neva R. Goodwin eds. (2001), *A Survey of Sustainable Development: Social and Economic Dimensions*, Washington, D.C.: Island Press.

Hazell, P., Poulton, C., Wiggins, S. and Dorward, A. (2007). *The Future of Small Farms for Poverty Reduction and Growth*. 2020 Discussion Paper No.42, IFPRI.

Holmberg, Johan ed. (1992), *Making Development Sustainable: Redefining Institutions, Policy, and Economics*, Washington, D.C.: Island Press.

Hossain, M., A. Janaiah, A.M.M. Husain and F. Naher. 2002. Rice Seed Delivery System and Seed Policy in Bangladesh. The dialogue was jointly organized by the Centre for Policy Dialogue (CPD) and IRRI on January 8, 2002 at the CIRDAP auditorium, Dhaka.

Hueting, R., Reijnders, L. (2004). Broad sustainability contra sustainability: the proper construction of sustainability indicators. Ecological Economics 50, 249– 260.

Jacobs, P., 2008. Market Development and Smallholder Farmers-A Selective Literature Survey. Background Paper for the "Second Economy Project", HSRC- CPEG.

Jacobs, P., 2008. Market Development and Smallholder Farmers-A Selective Literature Survey. Background Paper for the "Second Economy Project", HSRC- CPEG.

Jari, B., 2009. Institutional and technical factors influencing Agricultural marketing channel choices amongst Smallholder and emerging farmers in the Kat River Valley. Unpublished thesis (MSc. Agric. Econ.). Department of Agricultural Economics and Extension, University of Fort Hare, Alice.

Jones, R. B., P. Bramel, C. Longley, and T. Remington. 2002. The need to look beyond the production and provision of relief seed: experiences from southern Sudan. *Disasters* 26 (4): 302-315

Joshi G. R., (2011). Seed Enterprise Development in Nepal: Opportunities and Challenges

Kelly, R. D., and J. Rusike. 1997. The involvement of small scale private companies in seed multiplication and distribution in Southern Africa-a case study of Agricultural Seeds and Services (Pvt) Ltd. In *Alternative strategies for smallholder seed supply.* Ed. D. D. Rohrbach, Z. Bishaw, and A. J. G. van GastelICRISAT.

Kondyli, J. (2010). Measurement and evaluation of sustainable development a composite indicator for the islands of the North Aegean region, Greece. Environ Impact Assess Rev, 30, 347–56.

Kotler, P., 2010. What is marketing? [Online]. Available: http://www.learnmarketing.net/ marketing.

La via Campesina (2013). Our Seeds, Our future: *International Peasant Movement Operational Secretariat*, June 2013.1pp.

Leavy J. and Poulton C., (2007). Commercializations in Agriculture, Future Agricultures Sept. 2007.

Leeuwis, C. 2004 Communication for rural innovation. Oxford, UK: Blackwell Publishing.

Louwaars, N. 2009. Seed systems and PGRFA. Background Study Paper for the State of the World's Plant Genetic Resources for Food and Agriculture. FAO, Rome, Italy.

Mabuza, M.L., Ortmann, G., and Wale, E., 2013. Effects of transaction costs on mushroom producers" choice of marketing channels: implications for access to agricultural markets in Swaziland. *South African Journal of Economic and Management Sciences* 17 (1), pp. 99-111.

Machethe, C. L., 2004. Agriculture and Poverty in South Africa: Can Agriculture reduce poverty.

Machethe, C. L., 2004. Agriculture and Poverty in South Africa: Can Agriculture reduce poverty.

Makhura, M.N., and Wasike, W.S.K., 2003. Patterns of access to rural service infrastructure: the case of farming households in Limpopo Province. *Agrekon* 42 (2), pp.129-143.

Maredia, M., Howard, J., Boughton, D., Naseen, A., Wanzala, M. and Kajisa, K. 1999. Increasing seed system efficiency in Africa: Concepts, strategies and issues. MSU International Development Working Paper. Department of Agricultural Economics, Michigan State University, East Lansing, Michigan, USA. Available at: http://ageconsearch. umn.edu/bitstream/54578/2/idwp77.pdf

McMullen, M., Lamey, A., Plant diseases development and management, 2001, North Dakota State University, EB-31

Mele, P.V. 2005. Farmseed: Putting farmers at the heart of the seed system. Innovations in Rural Extension: Case Studies from Bangladesh. CABI Publishing, CABI International, United Kingdom. pp. 221-232.

Mkhabela, T.S., 2005. Technical efficiency in a vegetable. *Agrekon* 44 (2), pp. 187-204.

MoA (Ministry of Agriculture). 2006. Seed Wing, Bangladesh Secretariat, Ministry of Agriculture, Government of the Peoples' Republic of Bangladesh

MoA (Ministry of Agriculture). 2014. Seed Wing, Bangladesh Secretariat, Ministry of Agriculture, Government of the Peoples' Republic of Bangladesh

Mondal M. H., 2010. Crop Agriculture of Bangladesh: Challeneges and Opportunities. Bangladesh J.Agril. Res. 35(2):235-245.

Monroy-Ortiz, C., Garca-Moya, E., Romero-Manzanares, A., Sanchez-Quintanar, C., Luna-Cavazos, M., Uscanga-Mortera, E., Gonzalez-Romero, V. and Flores-Guido, J.S. (2009) Participative generation of local indicators for conservation in Morelos, Mexico. *Int. J Sustain Dev. World Ecol***16(6):**381–391

Muh, J.M., P. Omanga, and R. Jones. 1997. "Farmer-to-farmer seed supply: Case study of pigeonpea seed distribution in Kenya." In Rohrbach, D. D., Z.Bishaw, and A.J.G van Gastel. (eds.). *Alternative strategies for smallholder seed supply*. Zimbabwe: ICRISAT

Muliokela, S. W., 1998. Seed security: A case for Zambia. An international workshop on seed security for food security: Contributions for the development of seed security strategies in disaster prone region conference held in Florence Italy 30 November - 1 December 1997. Rome: Food and Agriculture Organization

Munda, G. (2005). Measuring sustainability: a multi-criterion framework. Environment, Development and Sustainability, 7, 117–134.

Munda, G. (2007). Social multi-criteria evaluation. Springer-Verlag, Heidelberg, New York, Economics Series.

Munda, G. (2008). Social multi-criteria evaluation for a sustainable economy. Springer-Verlag, New York.

Nardo, M., Saisana, M., Saltelli, A. and Tarantola. S. (2005). Tools for Composite Indicators Building. EUR 21682 EN European Communities, 2005.

Neck, P. (cd.) 1977. Small enterprise development: Policies and programs. International Labour Organization, Geneva, Switzerland.

Ngugi, D. N. 2004. Harmonization of seed policies and regulations in East Africa. In *Seed trade liberalization and agro-biodivrsity in Sub-Saharan Africa.* Ed. David Rohrbach, and Julie Howard. Bulawayo, Zimbabwe: ICRISAT.

NRC (National Research Council) (2010). Toward sustainable agricultural systems in the 21st century. The National Academics Press, Washington DC, Pp. 598 pages.

Ocran, V. K. 1997. The role of seed growers' associations in seed production and marketing in Africa. In *Alternative strategies for smallholder seed supply.* Ed. D. D. Rohrbach, Z. Bishaw, and A. J. G. van GastelICRISAT.

OECD, 2008. Handbook on constructing composite indicators: methodology and user guide. OECD, Paris.

Omiti J., Otieno, D., McCullogh, E. and Nyanamba, T. 2007. Strategies to promote market oriented smallholder agriculture in developing countries: A Case of Kenya. AAAE Conference Proceedings (2007), 259-264.

Omiti J., Otieno, D., McCullogh, E. and Nyanamba, T. 2007. Strategies to promote market oriented smallholder agriculture in developing countries: A Case of Kenya. AAAE Conference Proceedings (2007), 259-264.

Ortmann, G.F., and King, R.P., 2007. Agricultural cooperatives II: Can they facilitate access of small-scale farmers in South Africa to input and product markets? *Agrekon* 46 (2), pp. 219-244.

PAN AP and GRAIN. 2010. Asia's Seed Laws – Control over Farmers' Seeds. PAN AP Rice Sheet and seed wing, ministry of agriculture, 2014.

Pelmer, D. P. (2005). Agriculture in the developing world: connecting innovation in plant breeding research to downstream applications. *PNAS102* (44): 15739-15746.

Perman, R., Ma, Y., Mc Gilvray, J. and Common, M. (2003). Natural resource and environmental economics. Pearson Education Limited, USA.

Pezzey, J. C. and Toman, M. A. (2002). Progress and problems in the economics of sustainability In: International Yearbook of Environmental and Resource Economics

2002/2003 edited by Tietenberg T. and Folmer H., Edward Elgar, Cheltenham UK, pp. 265-332.

Pingali, P.L., 1997. From Subsistence to Commercial Production Systems: The Transformation of Asian Agriculture. *American Journal of Agricultural Economics*79(2),pp.628-634.

Pretty, J., Noble, A., Bossio, D., Dixon, J., Hine, R. E., Penning de Vries, P. & Morison, J. I. L. 2006 Resource conserving agriculture increases yields in developing countries. Environ. Sci. Technol. 40, 1114–1119. (doi:10. 1021/es051670d)

Probert, R.A., J. Coneybeer, J. Crawford and F.A. Hay. 2007. Seed quality for conservation is critically affected by pre-storage factors. *Australian Journal of Botany* 55(3): 326-335.

Reardon, T., Berdegué, J. and Escobar, G. (2001) "Rural Nonfarm Employment and Incomes in Latin America: Overview and Policy Implications," World Development. 29(3):411-425.

Reed, David ed. (1997), *Structural Adjustment, the Environment and Sustainable Development*, London: Earthscan Publications.

Rigby, D., Woodhouse, P., et al., (2001). Constructing a farm level indicator of sustainable agricultural practice. Ecol, Econ., 39, 463-478.

Roos,D.,2010.Marketingtoindependentretailers.[Online].Available:http://growingsmallfarms.ces.ncsu.edu/growingsmallfarms-marketingretailers/.

Rotberg, R.I., Gisselquist, R.M. (2008). Strengthening African governance. Ibrahim index of African governance: results and rankings, Kennedy School of Government, Massachusetts, October.

Roy, R., Chan, N.W. and Xenarios, QS (2015). Sustainability of rice production system: an empirical evaluation to improve policy. *Environment, Development and sustainability* 18(1): 257-278.

Roy, R., Chan, N. W., and Rainis, R. (2014). Rice farming sustainability assessment in Bangladesh. *Sustainability Science*. **9:** 31–44.

Roy, R., Chan, N.W. and Rainis, R. (2013). Development of indicators for sustainable rice farming in Bangladesh: A case study with participative multi-stakeholder involvement. *World Applied Science Journal*.**22:** 672–682.

Roy, R., and Chan, N. W. (2012). An assessment of agricultural sustainability indicators in Bangladesh: Review and synthesis. *Environmentalist.***32:** 99–110.

Royal London. (2017). *Sustainable withdrawals*. 1 Thistle Street, Edinburgh, London.

Rubyogo, J.C., Sperling, L., Nasirumbi, L. and Kasambara, C. 2007. Developing seed systems with and for the marginalized: case of common beans (*Phaseolus vulgaris* L.) in East, Central and Southern Africa. Paper presented at a Workshop on Farmer First Revisited: Farmer Participatory Research for Development, Institute of Development Studies, University of Sussex, UK, 12-14 December 2007.

Ruijs, A., 2002. Cereal Trade in Developing Countries: A Stochastic Equilibrium Analysis of Market Liberalisation and Institutional changes in Burkino Faso. Netherland: Labyrinth Publication.

Saisana, M., Tarantola S., Saltelli A. (2005). Uncertainty and sensitivity techniques as tools for the analysis and validation of composite indicators. Journal of the Royal Statistical Society A, 168, 1-17.

Sauvenier, X., Valckx, J., Cauwenbergh, N.V.,Wauters, E., Bachev, H., Biala, K. et al. (2005). Framework for assessing sustainability levels in Belgian agricultural systems-SAFE, technical report. Scientific Support Plan for a Sustainable Development Policy; 2005.

SEARICE. 2003. Seed supply system in commercially-irrigated areas: a case study from Sultan Kudarat, Philippines. *In* CIP-UPWARD. Conservation and Sustainable Use of Agricultural Biodiversity. A Sourcebook. International Potato Center-Users' Perspectives with Agricultural Research and Development, Los Banos, Laguna, Philippines. Pp. 226-235.

Sensi Seeds (2013).World Drug Report-Cannabis Seeds. February 6th 2013.

Singh, R.K., Murty, H.R., Gupta, S.K., Dikshit, A.K. (2007). Development of composite sustainability performance index for steel industry. Ecol. Ind. 7, 565– 588.

Smale, M., Cohen, J., Nagarajan, L., 2009, Local markets, local varieties – rising food prices and small farmers' access to seed, IFPRI Issue Brief 59

Smale, M., Nagarajan, L., Diakité, L., Audi, P., Grum, M., Jones, R. and Weltzien, E. 2009b. Tapping the potential of village markets to supply seed in semi-arid Africa: A Case Study Comparison from Mali and Kenya. Paper presented at the conference Towards Priority Action for Market Development for African Farmers, 13-15 May 2009, Nairobi, Kenya.

Spangenberg, J. H., Pfahl, S. and Deller, K. (2002). Towards indicators for institutional sustainability: lessons from an analysis of Agenda 21. Ecological Indicators, 2, 61-77.

Stavins, R. N., Wagner, A. F. and Wagner, G. (2002). Interpreting sustainability in economic terms: dynamic efficiency plus intergenerational equity', Resources for the Future, discussion paper.

Townsend, J.C. (1953). Introduction to experimental methods. International Student Edition. *New York: McGraw Hill Book Company*, Inc.

Tripp, R. 2003. How to cultivate a commercial seed sector. Paper presented at the symposium on 'Sustainable Agriculture for the Sahel', Bamako, Mali.

Tshuma, M.C., 2014. Understanding the small scale agricultural sector as a precondition for promoting rural development in South Africa. *African Journal of Agricultural Research* 9 (31), pp. 2409-2418 Bhopal, M.P., 2004.

Van der Hamsvoort, C. P. (2006). The allocation of scarce resources in miscellaneous cases, PhD thesis, Wageningen University.

Van Passel, S., Nevens, F., Mathijs, E. and Van Huylenbroeck, G. (2007). Measuring farm sustainability and explaining differences in sustainable efficiency. Ecological Economics, 62, 149-161.

WCED (World Commission on Environment and Development) (1987). Our Common Future, Oxford: Oxford University Press.

WEF (World Economic Forum), (2012).The global competitiveness report 2012– 2013, World Economic Forum Geneva.

World Bank, 2017. Governance and the law. World Development Report 2017. World Bank, Washington, DC. pp.307.

World Bank, (2007). *World Development Report 2008: Agriculture for Development*. Washington DC.

World Bank, (2007). *World Bank Assistance to Agriculture in Sub-Saharan Africa*: *An IEG Review*. Wahington DC.

World Bank (2006). Agriculture Investment Sourcebook. Washington, DC, World Bank.

World Bank. 1998. Initiatives for sustainable seed systems in Africa. In: FAO. Seed Policy and Programmes for Sub-Saharan Africa. Proceedings of the Regional Technical Meeting on Seed Policy and Programmes for Sub-Saharan Africa, Abijan, Côte d'Ivoire, 23-27 November 1998.

World Bank. 1998. Initiatives for sustainable seed systems in Africa. In: FAO. Seed Policy and Programmes for Sub-Saharan Africa. Proceedings of the Regional Technical Meeting on Seed Policy and Programmes for Sub-Saharan Africa, Abijan, Côte d'Ivoire

Yamane, T. (1967). Statistics: An introductory analysis, 2nd Ed., New York: Harper and Rao.

Zhen L, Routray JK et al (2005) Three dimensions of sustainability of farming practices in the North China Plain: a case study from Ningjin County of Shandong Province, PR China. Agric Ecosyst Environ 105(3):507–522.

Zuwarimwe, J. and Kirsten, J., 2010. The role of social networks in development of small-scale enterprises in the Chimanimani district of Zimbabwe. *Agrekon* 49 (1), pp. 17-38.

Appendix A

AN INTERVIEW SCHEDULE FOR A RESEARCH STUDY ENTITLED

Sustainability of Smallholder Seed Enterprise in Bangladesh

Date: Mobile no.:

Name of the respondent: Village:

Sub-district: District:

(Please answer the following question. Your information will be used for academic research purpose)

1. Human capital

Please answer the following questions:

Statement	Definitely (5)	Probably (4)	Probably not (3)	Not sure (2)	Definitely not (1)
Knowledge					
Soil fertility affects seed production					
Mixed cropping enhances soil nutrient availability					
Green manuring is important for soil health					
Access to market information is important for small scale seed business					
Skill					
Quality seeds are a base for good production					
Quality seed has good size, shape, colour and higher soundness & weight					
Seed sprouting promotes higher germination					
Seed conservation helps in saving money					
Capacity					
Balanced fertilizer is important for higher production					
ICTs access assists for getting updated information					
Extension service is key for farm management					
Financial capacity is urgent for adopting innovation					

2. Non-farm Income Generating Activities

Do you have any non-farm income generating activities?	Yes (1)	No (0)
If yes, please specify from the list		
Small business		
Seasonal business		
Private job		
Govt. job		
Casual labor		
Travel(driver, rickshaw puller)		
Shopkeeper		
Brick making		
Weaving (clothes)		
Other (specify)- max 1 score		

3. Access to financial services:

Do you have any access to financial support during the last 5 years?		Yes (1)	No (0)
If yes, please specify from the list of financial sources			
Financial sources	No access (0)	Intermittent access (1)	Sustained access (2)
Family			
Friends / Neighbors			
Bank			
Cooperative			
Microfinance			
Govt. program			
NGO			
Money lenders			
Remittance			
Other (specify)-max 1 score			

4. Utilization of seed of improved cultivars:

Do you use newly introduced (varieties/species which have been used in the community for less than 15 years) non-indigenous varieties, such as modern cultivars, imported cultivars, High Yield Varieties, etc.?	Yes (1)	No (0)	If yes, which ones (give name of variety for each crop)? (max 5 score)

Were some of these newly introduced varieties or poorly resistant to local biotic and abiotic stresses?		Yes (1)	No (0)
Approximately what percentage of your crops is a newly-introduced variety?	Low (1)	Medium (2)	High (3)

5. Market prices of Seeds

Describe the most important products you sell	Describe the price of this products			
	High (3)	Fluctuating (2)	Unpredictable (1)	Too low (0)
Rice				
wheat				
Maize				
Jute				
Mustered				
Potato				
Pulse				
Others (specify….)-max 1 score				

6. Marketing facility

Facility	Very Good (4)	Good (3)	No Opinion (2)	Not Good (1)	Not Good at all (0)
Adequate marketing infrastructure					
Condition of roads and highways					
Availability of local transport means					
Government monitoring for keeping stable price					
Government collection initiatives					
Intervention of middle men					
Conducive marketing environment e.g. tax					

7. Adequacy of extension services

Please mention the extent of extension contact in the last year

Service	Extent of extension contact in the past year			
	No visit (0)	Once (1)	2 to 3 times (2)	4 times & above (3)
Extension officers visit to farmers				
Farmers visits to extension officers				
Fisheries extension officer visits to farmer				
Farmers visits to fisheries extension officer				

8. Information accessibility

Medium	Available		Accessible	
	Yes (1)	No (0)	Yes (1)	No (0)
Radio				
TV				
Newspaper				
Leaflet, poster, booklet				
NGO workers				
Senior person				
Fellow farmer				
Input dealer				
Relative				
Personal experience				
Neighbor				
Local leader				

9. Institutional function:

Function		A great deal (4)	Quite a lot (3)	No opinion (2)	Not very much (1)	Not at all(0)
Commitment	Local government's commitment is credible					
	leader's commitment to keep reliable rice market price is believable					
	Commitment for development of farming communities is trusted					
Coordination	Extension organization coordinates in taking farming decision					
	Local banks and NGOs coordinates in starting agricultural business					
	Coordination among government and dealers reliable agricultural input's price is observed					
Cooperation	Extension officers timely cooperate in pest and disease management					
	NGOs cooperate in giving microcredit					
	Social organization cooperates in agricultural risk (flood/salinity)management					

Thanks for your information, time and patience. ……...

Signature of the interviewer

Appendix B

Correlation among dependent variables and Sustainability index

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
X_1	1									
X_2	.198(*)	1								
X_3	-.146	-.074	1							
X_4	.180(*)	-.046	-.053	1						
X_5	-.161	-.209(*)	.145	.294(**)	1					
X_6	.091	-.340(**)	.005	-.042	-.010	1				
X_7	.300(**)	.180(*)	-.097	.353(**)	.238(*)	-.200(*)	1			
X_8	.038(**)	-.085	.105	.342(**)	.228(*)	.059	.198(*)	1		
X_9	.045	-.143	.112	.227(*)	.117	.278(**)	.136	.235(*)	1	
X_{10}	.284(**)	-.128	.159	.317(**)	.395(**)	.320(**)	.319(**)	.360(**)	.574(**)	1

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Legends:

X_1=human capital, X_2=non-farm income generating activities, X_3=access to financial services, X_4=utilization of seeds of improved cultivars, X_5=market prices of seeds, X_6=marketing facility, X_7=adequacy of extension services, X_8=information accessibility, X_9=institutional function, X_{10}=sustainability index

Appendix c

Dependent Variables for Regression Analysis (Based on Index sustainability Value)			
49	44	54	52
50	42	53	43
42	53	61	46
63	54	32	57
35	46	57	60
47	64	42	51
60	48	58	39
50	59	50	49
53	33	58	34
59	61	45	43
30	49	49	49
53	54	42	42
49	54	49	50
57	51	59	56
52	45	54	47
55	55	63	50
57	49	57	49
46	39	46	40
48	49	54	42
49	39	61	53
35	42	51	49
60	41	51	63
41	27	55	37
45	54	34	50
53	45	51	58
52	46	41	33
37	64	38	46
40	56	58	55
53	50	55	45
40	51	39	46