Strengthening Seed Systems

Promoting Community Based Seed Systems for Biodiversity Conservation and Food & Nutrition Security in South Asia

Editors

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SAARC Regional Exposure Visit for "Partnership to Strengthen Community Based Seed Systems in South Asia", 7-9 November 2019, Islamabad, Pakistan.

Edited by

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Published by the SAARC Agriculture Centre (SAC), Dhaka, Bangladesh; the Asian Farmers' Association (AFA), the Philippines; and the Pakistan Agricultural Research Council (PARC), Pakistan. (Available at www.sac.org.bd)

ISBN: 978-984-34-8590-8

Citation

Shrestha, R.B., Penunia, M.E., Asim, M., (eds). 2020. Strengthening Seed Systems—Promoting Community Based Seed Systems for Biodiversity Conservation and Food & Nutrition Security in South Asia. SAARC Agriculture Center, Bangladesh; Asian Farmers' Association, the Philippines; and Pakistan Agricultural Research Council, Pakistan. 210 p.

This book contains papers of the "SAARC Regional Exposure Visit for Partnership to Strengthen Community Based Seed Systems in South Asia" conducted in Islamabad, Pakistan during 7-9 November 2019. The program was jointly organized by the SAARC Agriculture Centre, Bangladesh; the Asian Farmers' Association, the Philippines; and the Pakistan Agricultural Research Council, Pakistan. The opinions expressed in this publication are those of the authors and do not imply any opinion whatsoever on the part of publishers, especially concerning the legal status of any country, territory, city or area or its authorities, or concerning the delimitation of its frontiers or boundaries.

Cover Design: S. Rahman Firoz

Printed by: Momin Offset Press, Dhaka.

Price: US$ 15 for SAARC countries and US$ 30 for other countries.

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Food is the moral right of all who are born into this world

- Norman E Borlaug

Investing in agriculture for a better future

- FAO of the United Nations

Foreword

Seed accessibility, availability and affordability in planting season to the smallholder farmers are the major challenges in the developing economies, particularly in South Asia region. Studies proved that improved seeds increase the yields by 20-30%. More than 80% of the seeds are used from the informal sources and the Community Based Seed System (CBSS)–farmers' production, process, storage, farmers' exchange and use, is the common practice in the farming communities. However, promoting such seeds are not in the priority area of the governments so that wider yield gaps exist between the actual yields and potentials.

As the seeds form CBSS are climate resilient, nutrition sensitive and the major means of food security, the SAARC Agriculture Center (SAC) based in Dhaka, Bangladesh in collaboration with the Asian Farmers' Association (AFA) and the Pakistan Agricultural Research Council (PARC), Islamabad, organized a program on "Regional Exposure Visit for Partnership to Strengthen Community Based Seed Systems in South Asia", during 7-9 November 2019, Islamabad, Pakistan.

As an output of this program, this book entitled "Strengthening Seed Systems: Promoting Community Based Seed Systems for Biodiversity Conservation and Food & Nutrition Security in South Asia" has been published. I am sure that it would be very much useful for formulating policies at the country level and at the South Asia regional level to attain SDG targets, particularly ending poverty and hunger, climate action and economic growth. Furthermore, this book is more valuable to cope up with shortage of seeds because of the effects of COVID-19 to the smallholder family farmers through community based seed systems approach.

I would express my sincere gratitude to Dr. Rudra Bahadur Shrestha, Senior Program Specialist (Policy Planning), SAC; Ma. Estrella Penunia, Secretary General, AFA and Dr. Muhammad Asim, Director, Plant Sciences Division, PARC for their untiring efforts in organizing the program and publishing this valuable Volume.

I appreciate Asian Farmers' Association, Pakistan Agricultural Research Council, Member States of SAARC, authors, and reviewers for their outstanding contributions.

Dr. Mian Sayeed Hassan
Director, SAARC Agriculture Center
Dhaka, Bangladesh

Message

South Asian agriculture is primarily encountered by small scale farming with major challenge is lack of access of improved seed varieties in terms of quality, quantity, and affordability in time of planting season, particularly to the smallholder farmers. More than 80% seeds are from the informal source, particularly farmers' own seed system– "Community Based Seed System (CBSS)" where farmers produce, process, storage, exchange and use at the community level. The seeds form CBSS are climate resilient, locally adopted and major means of food security. Thus the SAARC Agriculture Center (SAC) in collaboration with the Asian Farmers' Association (AFA) and the Pakistan Agricultural Research Council (PARC), Islamabad, organized a program on "Regional Exposure Visit for Partnership to Strengthen Community Based Seed Systems in South Asia", during 7-9 November 2019, Islamabad, Pakistan.

This book entitled "Strengthening Seed Systems: Promoting Community Based Seed Systems for Biodiversity Conservation and Food & Nutrition Security in South Asia" has been published as an output of this program. This volume would be useful for formulating policies at the country level and at the South Asia regional level, particularly in ending poverty and hunger, climate resilient, biodiversity conservation and sustainable economic development. This book would contribute to cope up with the effects of COVID-19 to be available quality seeds to the smallholder family farmers through CBSS.

I would express my sincere gratitude to Dr. Rudra Bahadur Shrestha, Senior Program Specialist (Policy Planning), SAC; Ma. Estrella Penunia, Secretary General, AFA and Dr. Muhammad Asim, Director, Plant Sciences Division, PARC for their untiring efforts to come up with this valuable Volume. I appreciate SAARC Agriculture Center, Asian Farmers' Association, Pakistan Agricultural Research Council, authors, and reviewers for their contributions to bring this volume published.

Dr. S. M. Bokhtiar
Executive Chairman
Bangladesh Agricultural Research Council
Dhaka, Bangladesh

PAKISTAN AGRICULTURAL RESEARCH COUNCIL

No.D.O.1-4/2020-Ch (PARC)
April 08, 2020

MESSAGE

I am pleased to know that the proceedings of "*Regional Exposure Visit for Partnership to Strengthen Community Based Seed Systems in South Asia*" have been compiled and is now being published by SAARC Agriculture Centre (SAC), Dhaka as a book.

The event was jointly organized by SAC, Asian Farmers Association (AFA) and Pakistan Agricultural Research Council (PARC), Islamabad during 5-7 November, 2019. The deliberations were focused on improving food and nutritional security in the SAARC member states using community-based seed systems.

Food and nutritional security are one of the priority areas for each member state and is also in line with SDGs. This warrants the need to promote innovation, diversification and modernization in agricultural sector. To guarantee food and nutritional security, it is necessary to enhance domestic agricultural production through increased productivity. This calls for efficient utilization of production resources by adopting modern technologies and using quality seed.

In enhancing crop productivity, seed is the basic input and has an imperative role. In spite of rapid evolution of varieties, the rate of adoption of improved seed in SAARC member countries is significantly low, partly due to the inefficiency of local seed production systems.

Community based seed system is playing a significant role in many Asian countries. This, however, needs further strengthening for seed multiplication of latest approved varieties with the collaboration of respective seed registration and certification agency in each SAARC member State. Public sector research organizations can also assist this approach of seed production and distribution in many ways. The most important initiative include enhanced access to foundation seed, extension of advice on seed production, processing, treatment & storage, and a legal framework that permits the marketing of various categories of seed. This will facilitate the growth of small-scale entrepreneurs in the seed sector.

I hope the recommendations emanating from this endeavor will help in identifying ways and means for future regional cooperation and for the betterment of the communities particularly with regards to this very important sector.

(Dr. Muhammad Azeem Khan)
Chairman

P.O. Box 1031, Plot 20, G-5/1, Islamabad, Pakistan. Tel: +(92-51) 9203966, PABX No. 90762000
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Preface

We are pleased to co-publish this book entitled "Strengthening Seed Systems: Promoting Community Based Seed Systems for Biodiversity Conservation and Food and Nutrition Security in South Asia", together with the SAARC Agriculture Center (SAC) and the Pakistan Agricultural Research Council (PARC). This book contains the important papers presented during a regional meeting on Partnerships to Strengthen Community Based Seed Systems in South Asia" held last November 5-7, 2019 at Islamabad, Pakistan.

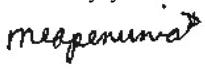
Seeds are very important natural resource for all family farmers, along with land, waters and forests. Seeds are the heart of agriculture; having seeds at the right time, with the right quality, with the right quantity and at affordable prices is a basic need of farmers from the very beginning of the production cycle. Different varieties of seed promote biodiversity which is an important adaptation and mitigation measure to cushion and combat the impact of climate change.

From time immemorial, seeds have been saved, improved, shared and exchanged by farmers, giving a wealth of traditional knowledge on seed improvement and management. However, today, the majority of the seed market is controlled by a few giant multinational seed conglomerates who dominates the commercial seed business and rakes the biggest profit. However, in South Asia, 70-90% of the demand for seeds are met by the informal seed system, with farmers, either as individuals or as organized into community based seed banks, groups, villages or cooperatives. Where these groups are functional, managed effectively and are in close partnership with the public seed centers, they are able to meet farmers' seed demands in a quality and satisfactory manner.

I am writing this amidst the harvest season but with Covid-19 lockdowns, when transportation restrictions closed markets, greatly reducing the incomes of family farmers. In the coming planting season, farmers are anxious where to get quality seeds especially if the lockdowns continue.

In AFA, we see the potential of community based seed groups, managed by family farmers, especially the women, in the upscaling of efforts for a more responsive, participatory, equitable and just, resilient, inclusive, dynamic and empowering seed system in a country. We hope this can be part of "the new normal" post Covid-19. We are happy that SAC is a key partner in this endeavor. This is the second in what we hope to be a series of fora for the next five years, to strengthen the partnership between government, private sector and farmers for an integrated seed system that harnesses the potentials of the community based seed system. We thank development partners, including FAO, IFAD, and GAFSP for the support we receive to undertake this endeavor.

Sincerely yours,



Ma. Estrella Penunia
Secretary General
Asian Farmers' Association for Sustainable Rural Development (AFA)

Acknowledgment

The present Volume "Strengthening Seed Systems: Promoting Community Based Seed Systems for Biodiversity Conservation and Food & Nutrition Security in South Asia" is an output of a Regional Exposure Visit for "Partnership to Strengthen Community Based Seed Systems in South Asia", organized by the SAARC Agriculture Center (SAC), the Asian Farmers' Association for Sustainable Rural Development (AFA) and the Pakistan Agricultural Research Council (PARC) during 7-9 November 2019, Islamabad, Pakistan.

In this forum, the government representatives from SAARC Member States, experts, researchers, and farmers' organizations were participated with innovative ideas and experience that contributed to come up with this Volume. Thus, we are delighted to publish this book, which would be useful to formulate policies on strengthening the seed systems in general, Community Based Seed Systems (CBSS) in particular, for biodiversity conservation, food security and nutrition in the South Asia region.

We would express our sincere gratitude to the SAARC Agriculture Center (SAC); the Asian Farmers' Association (AFA); the Pakistan Agricultural Research Council (PARC); the SAARC Member States, particularly the Ministry of Foreign/ External Affairs and Ministry of Agriculture; SAARC Secretariat; National Focal Point Experts; and Farmers Organizations for their significant contributions. We appreciate to Dr. S. M. Bokhtiar, Director, SAARC Agriculture Center (SAC) and the SAC team; AFA team; and PARC team for their outstanding contributions.

Last but not the least, we would express our gracious appreciations to Dr. Umar Farooq, Member, Social Science Division, PARC and Dr. Muhammad Ayub Khan, Member, Plant Science Division, PARC for their significant contributions in coordinating and organizing the program successfully.

Dr. Rudra B. Shrestha
Senior Program Specialist,
SAC, Bangladesh

Ma. Estrella Penunia
Secretary General
AFA, Philippines

Dr. Muhammad Asim
Director (Plant Sciences Division), PARC, Pakistan

Acronyms

ABS	Access and Benefit Sharing
ADS	Agriculture Development Strategy
AFA	Asian Farmers' Association for Sustainable Rural Development
AKC	Agriculture Knowledge Centre
BS	Breeder Seed
CBM	Community Biodiversity Management
CBO	Community Based Organization
CBSPG	Community Based Seed Production Group
CBSPO	Community Based Seed Producers' Organization
CBSS	Community Based Seed System
CBSV	Community Based Seed Villages
CSB	Community Seed Bank
CSO	Civil Society Organization
DISPRO	District Seed Self Sufficiency Program
DUS	Distinctness, Uniformity and Stability
EPB	Evolutionary Plant Breeding
FO	Farmers' Organization
FR	Farmers' Rights
FRC	Farmer Resource Center
FS	Foundation Seed
FSF	Future Smart Food
FSS	Formal Seed System
GE	Genetically Engineered
GMO	Genetically Modified Organization
HiHi	Hand in Hand Initiative
HYV	High Yielding Varieties
IPR	Intellectual Property Rights

ISS	Informal Seed System
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
MTA	Material Transfer Agreement
MVs	Modern Varieties
NARES	National Research and Extension System
NFSS	Non-Formal Seed System
NUS	Neglected and Underutilized Species
OPV	Open Pollinated Varieties
PGR	Plant Genetic Resources
POD	Protocol of Discussion
PPB	Participatory Plant Breeding
PSC	Private Seed Companies
PVS	Participatory Variety Selection
R&D	Research and Development
SAARC	South Asian Association for Regional Cooperation
SAC	SAARC Agriculture Center
SCA	Seed Certification Agency
SCS	Seed Certification Service
SDGs	Sustainable Development Goals
SFSS	Semi-Formal Seed System
SRI	System of Rice Intensification
SRR	Seed Replacement Rate
SSR	Self-Sufficiency Ratio
SWOT	Strength, Weakness, Opportunity, Threat
TLS	Truthfully Labelled Seed

Highlights of the Book

- This book is an output of a regional experts' consultation program on "Partnership to Strengthen Community Based Seed Systems in South Asia", organized by the SAARC Agriculture Center (SAC), Dhaka; the Asian Farmers Association (AFA), the Philippines; and the Pakistan Agricultural Research Council (PARC), Pakistan during 7-9 November 2019, Islamabad, Pakistan. This book has ownership of the SAARC Member States' National Focal Point Experts, authors, editors and publishers.
- This book focuses on the seed systems in general, the Community Based Seed System (CBSS) in particular, in relation to biodiversity conservation and food & nutrition security; improved seed systems; country-specific constraints, challenges, opportunities, prospects and policies.
- This book is consistent with the global goals (Sustainable Development Goals–SDGs), international declarations and commitments on Farmers' Rights (ITPGRFA, UN Declaration on the Rights of Peasants and Other People Working in Rural Areas, UN Decade of Family Farming), regional initiatives, and country perspectives.
- This Volume suggests some major policy interventions include: i) Strengthen CBSS by formulating the government's policies and regular program framework; ii) Promote farmers' right in seed production, saving, utilization, exchange and sale; iii) Link CBSS with the multi-national and national seed companies; iv) Formalize the registration and release process of CBSS seeds; v) Promote in-situ practices and conservation of the biodiversity; vi) Leverage CBSS with Future Smart Food–promote nutrition sensitive agriculture, and neglected underutilized nutrition rich crops; and vii) Enhance the integrated efforts of the development partners and stakeholders in the seed value chain.
- This book is useful for the smallholder farmers, community seed producing groups, researchers, academicians, public and private seed companies, development professionals, policymakers, governments, international organizations, development partners, and civil societies to gain the synergetic efforts for strengthening CBSS in order to contribute for biodiversity conservation and food & nutrition security in South Asia.

Contents

Thematic Paper- Regional Perspective

Chapter 1

Strengthening Seed Systems and Farmers' Rights for Improving Food & Nutrition Security in South Asia

Rudra Bahadur Shrestha[1*] and **Devendra Gauchan**[2]

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Abstract

Access to improved seeds to the smallholder farmers in the rural areas is intertwining and enduring challenge in the developing economies. Lack of access to improved quality seeds makes the agriculture system less productive and competitive making the rural people more vulnerable, marginalized, and food insecure. This paper has been prepared adopting secondary information and literature review aiming to assess the seed system, particularly the Community Based Seed System (CBSS) and its relationship with economic development and food security. It also briefly outlines status of seed and agrobiodiversity related national and international policies and farmers rights issues including recent SAARC initiatives made in strengthening the seed system in South Asia. We therefore recommend some major policy interventions: i) Strengthen the CBSS through the government's policies and regular program framework; ii) Promote farmers' right in seed production, saving, utilization, sale, and natural resource management under TRIPS, ITPGRFA, UN Declaration on the Rights of Peasants and Other People Working in Rural Areas; iii) Strengthen the private seed sectors; iv) Formalize the registration and release process of the community seed system; v) Promote the in-situ practices and conservation of the biodiversity; vi) Link the CBSS with Future Smart Food—promoting nutrition sensitive agriculture, and neglected underutilized nutrition rich crops; and vii) Enhance the integrated efforts of the development partners and stakeholders in the seed value chain. The seed system, particularly the CBSS approach and ensuring farmers' rights linking with Sustainable Development Goals (SDGs) could certainly improve the food and nutrition security of smallholder farmers and marginalized groups of people in South Asia.

Keywords: Seed systems, farmers' right, food security, policies, South Asia

1. Introduction

Seed, as a primary basic input of agriculture is deeply associated with the whole food system. The quality of seeds to be accessed and available with affordable cost in planting session to the smallholder farmers is the major challenge in the developing countries, and more pronounced in South Asia. The seed security is profoundly linked with food security and improved livelihoods of people, particularly the women, children, and marginal groups of excluded people in the rural areas. In general case, the seeds are saved by farmers and exchanged among themselves and improved in accordance to local environmental conditions from time immemorial. The conventional knowledge, traditions, practices and customs for seed saving and exchange among farmers could differ in each local communities. In the developing world, informal markets are the most important sources of seed for small farmers for most food crops, except for maize and vegetables (Bänziger et al., 2004). The seed policies are intended to ensure the farmers' requirements, mainly the small-scale farmers, have access to quality seeds of major crops in planting time. **The farmers' access of such improved seeds has been constrained by**: i) Lack of financial resources to purchase seeds and associated inputs (such as fertilizers and pesticides); ii) Weak market access to seeds; iii) Uncertainty on the advantages of new germplasm as opposed to local varieties; iv) Lack of knowledge to develop quality seeds; v) Uncertainty on yields and fluctuating product prices; vi) Lack of capacity to meet phytosanitary requirements; and vii) Lack of recognition and supports for the seeds produced by small farmers' seed systems.

However, phenomenon of saving and sharing of seeds among farmers have gradually changed with time due to changes in the technology development consistent with the changing environment. With rapid change of agricultural technology development, traditional seed systems, which were controlled by farmers have eventually moved to government sector, plant breeders, and private seed companies. This shift was caused mainly by technological advancement such as hybridization and genetic improvement associated with green revolution (Shrestha & Thapa, 2019). Legal protectants and property rights of seed production accelerated the shift and making the situation conducive for seed companies to earn more profits. This seed system, as captured by limited business companies, has been adversely affecting the conventional seed saving, replanting and sharing process, and hurt to the rural poor farmers who are not able to access seeds on time during crisis seasons.

Recently, the majority of the seed market is controlled by a few giant multinational seed conglomerates. These big seed corporations continue to acquire many small scale seed companies in order to maintain the monopoly power in seed business. Seed research and seed production are confined only towards most profitable proprietary crops and varieties, which in turn adversely affect seed diversity. In fact, this is the oligopolistic market structure where limited multinational seed companies controlled the seed system that counteract effects to the lack of access of seeds to the farmers, worsen the farmers' rights, and deteriorate the genetic resources.

The traditional knowledge and practices of saving seeds have been lost as farmers are refrained from such activities. **There are Four Implications of using hybrid seeds:** i) Genetic diversities have been lost; ii) Lost of local knowledge and practices; iii) Small farmers cannot access seeds easily in planting time due to high cost of seeds and dependency on seed companies; and iv) Farmers can be at risk since farmers are not ensured if the hybrid seeds will properly give production. As a consequence, the vulnerability of the farmers has been increasing rapidly, making the farmers more marginalized, and eventually lead the farmers towards food insecurity. Meanwhile, farmers in South Asia are more vulnerable as more than 60% of the total 1.891 billion population in South Asia depend their economy and livelihoods on agriculture (FAOSTAT, 2019), and most of them (80%) are smallholders and they live in rural areas (UN, 2019).

Major issues in seed system is quality, truthfulness, quantity, timely availability and affordability of crop seeds to the local farmers that have to be addressed by the respective member countries in South Asia. In the meantime, the role of SAARC Agriculture Centre (SAC) has increased to facilitate and coordinate among the respective governments, private sectors, seed companies, farmers' cooperatives, and community based seed organizations. The CBSS approach has been established more popular means for saving and exchanging seeds at the local condition and distributing it in the rural areas. Adopting this approach would have long-term impact on enhancing agricultural productivity, ensuring food and nutrition security, and alleviate poverty among smallholders in South Asia. Therefore, this Volume and the paper has been developed for strengthening the CBSS for conserving the biodiversity and improving the food and nutrition security in South Asia.

2. SWOT Analysis of Seed Sector in South Asia

The SWOT analysis consists of Strength, Opportunity, Weakness and Threat. The internal factors are considered as strength and weakness, which can be controlled by the internal mechanism, while opportunity and threat are external factors, which are out of the control of the internal management.

The seed system has been analyzed using SWOT approach. **The strength of the seed sector in South Asia includes:** i) High demand of improved seeds; ii) Presence of well-organized public sector–in organizational structure, policies, acts and programs for promoting seed system; iii) Diversified agro-ecological settings and agro-biodiversity; and iv) Emerging private sector and farmers' cooperatives in seed system. Similarly, **the opportunities of improved seeds are:** i) Large gap between demand-supply; ii) Wide scope of formulating national seed systems–plans, rules and regulations to develop; iii) Involvement of Public Private Partnership (PPP) in seed sector; iv) Rich in agrobiodiversity–wider scope for developing diverse crop varieties; v) Increased scope for regional seed trade/ market integration among the SAARC Member States; and vi) Economic liberalization and open trade regime among the member countries.

The major constraint encountered by the farmer is heavy inflow of informal seeds, which causes uncertainty for the quality and optimum quantity of production. The seed sector in South Asia has suffered several **weaknesses that include:** i) Lack of processing, storage and value addition facilities; ii) Limited trained manpower including farmers, technicians and companies; and iii) Poor resource allocation and lack of investment for seed system improvement. This sector is threatened by higher competition of improved seeds between the locally produced seeds and big companies. **The threats of this sector are:** i) Climate change and biotic & abiotic stress; ii) Dominant informal seed systems with less standardized seeds available to farmers; iii) Occupational migration of trained manpower (agriculturist) to non-agriculture sector or out-migration; iv) Competition among domestic seed systems and global multi-national companies in seed business.

Therefore, it is crucial to utilize the strength, grasp the opportunities, resolve the weakness and cope up with threats in the seed sector. All the concerned stakeholders including governments, private sectors, farmers' communities, researchers, scientists, extension agents, and value chain actors should have integrated and synergetic efforts.

3. Seed Security and Food Security

3.1 Household Seed Security Framework

Household Seed security exists when men and women within the household have sufficient access to quantities of available good quality seed and planting materials of preferred crop varieties at all times in both good and bad cropping seasons (FAO & ECHA, 2015). **The definition contains Five Pillars in order to ensure seed security** (Figure 1): i) Seed availability—seed supply at the right time and place; ii) Seed access—means and ability of farmers to acquire seeds in affordable price and in right time; iii) Seed quality—germination, physical purity, free from pests and diseases; iv) Varietal suitability—adapted crop varieties farmers prefer and need; and v) Stability of seed system in the context of shocks and stresses (resilience). Indeed, these seed security pillars are derived from the food security elements such as food availability, food access, food quality, food preferences, and stability of food security in the context of shocks and stresses.

Seed Availability is the condition when adequate availability of seeds exists from different sources—own saved seed, social networks, in local markets, the formal seed sector, and from seed aid suppliers to meet the seed requirements of local farmers. The seed should be in reasonable proximity to the farmer and be available in time for planting.

Seed Access— exist when farmers have the ability to acquire seed through purchase, loan, exchange, barter or use of power in social networks.

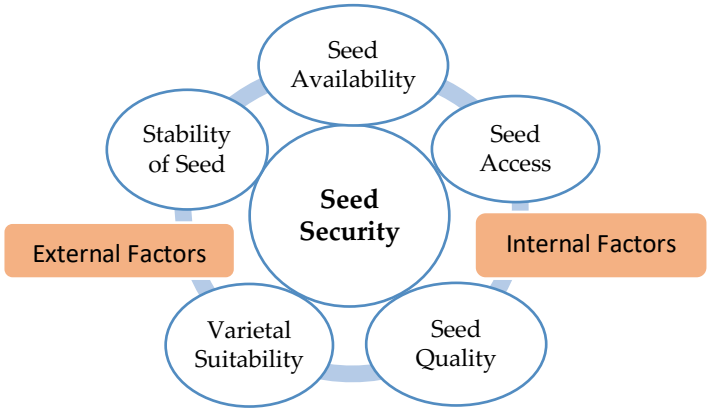

Figure 1. Seed security framework

Source: Authors' Synthesis (2020)

Varietal Suitability—the accessed seeds of crop varieties, which the farmers prefer among the range of desirable characteristics. The characteristics may include: appearance, taste, aroma, storability, ability to produce fodder, high income potential, high production potential, disease and pest resistance, and whether extreme resistance in the fields. The farmers require seeds that they know, have a preference for and are confident to get higher yield and benefit. The quality of seeds is an important parameter in agricultural development as 20-30% of the crop yields may increase only because of using improved seed varieties.

Seed Quality is a technical factor that includes: germination, physical purity, varietal purity, and seed health.

Resilience of the Seed System is the capacity of the seed system that can resist, adapt to and recover from biotic (disease and pest) and abiotic stress (drought, floods, water logging, etc.) and shocks, which threaten the household income, food and nutrition security and livelihoods. The whole seed system should contribute to adequate access to sufficient quantities of adapted and preferred seed at all times in both good and bad cropping seasons.

3.2 Seed Security Contributes to Food System

The needs of food production have been under increasing pressure to feed the ever growing global population, shifting of structural dietary, food habits and climate change effects. The United Nations (UN) signaled that food and nutrition security is being threatened by a changing climate, particularly in areas where the livelihood of a high proportion of the population depends on agriculture (Layzell, 2019). As the number of hungry people increased from 784 million in 2014 to nearly 821 million in 2017, indicated that the undernourishment is worsening in the world, particularly in Latin America and most regions of Africa, whereas the situation in Asia has stabilized but not improved (Layzell, 2019). In fact, food production is increasing over the year, while the post-harvest losses are also increasing by 20-35% (depends on the crop types) that resulted out the scarcity of foods for ever growing population. This implied that there is prompting need of increasing food production in sustainable intensification pathway of reducing the post-harvest losses, without depleting the world's resources and causing potentially irreversible environmental damage.

Food security depends on seed security as seeds are the foundation for agriculture and food production. The delivery of high-quality improved seeds to farmers is crucial for enhancing sustainable crop production adapting environmental challenges. The importance of seed provisioning in food security and nutrition, agricultural development and rural livelihoods, and agrobiodiversity and germplasm conservation are well accepted by policy makers, practitioners and researchers (Coomes et al., 2015). The technology development in seed system has been more advanced, however it is continuous and ongoing process complying with several external and internal factors where plant breeders and biotechnologists play pivotal role. There is a needs of improving the desirable characteristics of plants including high yielding, biotic and abiotic stress tolerance, rich in nutrition value, capacity to adapt in the particular environment, demand of markets and farmers' preference. Such seed improvement requires huge investments, larger number with capitated human resources (scientists and technologists), and conducive government policy environment. Furthermore, developing improved seed varieties should be based on the traits of existing local variety of crops, thus crop diversification and seed conservation is crucial endeavor.

The global seed industry is made up of a small group of large global players and a long tail of small and medium enterprises that operate at regional, national and local levels (Layzell, 2019). The global seed system use the integrated seed business model, which includes research and development, seed production, marketing and sales, and capacity building of the small and medium companies. The large majority of the world's more than 570 million farms are small and family-run. The small farms refer to those having less than 2 hectares of farm land, account for about 12% and family farms account for about 75% of the world's agricultural land (Layzell, 2019). Their contribution to food production is key to achieving the SDGs, which is the major challenge. Gill et al. (2013) argued that these smallholders depend on informal seed systems for 75-90% of their food crop cultivation in Southeast Asia, where the region is one of the world's biodiversity hotspots in the face of rapidly dwindling global genetic diversity. Similarly, South Asian countries have also rich biodiversity in agriculture due to presence of diverse agroecology, farming systems and socioeconomic diversity.

3.3 Seed Enterprise Development and Food Security

A larger portion of the global population is smallholders estimated to be 570 million farmers operated by family, which has been recognized by United

Nations as the UN Decade of Family Farming (2019-2028). UN realized that the family farmers are handicapped by access to inputs including improved seeds and fertilizers, access to markets, lack of financial facilities and limited improved technology. Unless improving the socio-economic status of this larger proportion of the global population, the targets of the Sustainable Development Goals (17 SDGs) won't be fulfilled. This paper therefore analyzed a framework on the relationship of the seed enterprises run by farmers, and its relationship with poverty and hunger (Figure 2). It shows that as smaller the farms size, the higher the poverty and food insecurity, and consequent effects to be vulnerability. Meanwhile, community seed system is the foundation for seed conservation and availability at the local level and that can be used for crop diversification and eventually contribute to local food security. The role of the breeders and innovators is also important that help to develop the new crop varieties suitable for the particular locations including the role of other concerned stakeholders who can support and involve in supporting in the whole process.

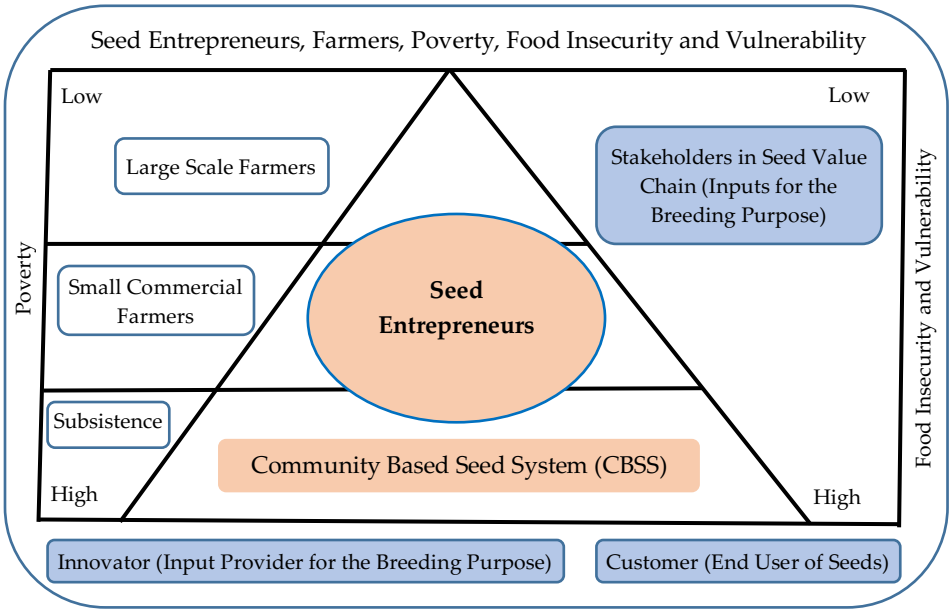

Figure 2. Framework on seed entrepreneurs, poverty and food insecurity

Source: Author's Synthesis (2020)

The **key success factors for promoting seed enterprise development** as suggested by Scowcroft & Polak Scowcroft (1998) and FAO (2010) are: i) Conducive policy environment at the national level—on plant improvement and variety development; variety evaluation, registration and release; plant

variety rights; seed certification; production, storage and marketing; strengthening seed supply systems; farm and community seed production; developing capacity in seed multiplication; establish sensible seed quality protocols; and promotion of production and marketing of high-quality seed; ii) Effective demand of seeds that farmers are able to purchase seeds; iii) Availability of improved seed cultivars to the farmers; iv) Price of the seeds—should be affordable to the smallholder farmers; v) Availability of subsidized credit facility to the farmers to purchase improved seeds, and equipment; vi) Technical expertise and linkages with R&D and extension services; vii) Markets and marketing information—enterprise should have easy access to markets along with necessary information in the market chains for inputs and outputs; viii) Capacity building of farmers, company, cooperatives; ix) Quality control of seeds—regular monitoring required; x) Infrastructure support, particularly processing and storage facilities; xi) Community participation; xii) Focus on complete package of agricultural value chain development; xiii) Linkage with formal and informal seed sectors. However, the farmers and seed entrepreneurs have encountered constraints with several factors that include high costs of seed production, processing and storage; high cost of complying the legal requirements for seed marketing; and informal seed market.

3.4 Seed System for Achieving SDGs

According to Layzell (2019) the global seed companies committed to contribute Sustainable Development Goals, including SDG-1 (No Poverty), SDG-2 (Zero Hunger), SDG-8 (Decent Work and Economic Growth), SDG-12 (Responsible Production and Consumption) and SDG-13 (Climate Action). In addition to the CBSS, empowering the domestic seed companies aligning with global seed companies to engage in seeds is crucial to end poverty and hunger, improve health and education, protect and promote the sustainable use of ecosystems, combat climate change, and protect oceans and forests. The effects of climate change can be reduced with appropriate climate resilient agriculture approach consisting of developing stress tolerant and high yielding crop varieties, developing innovative technologies in consistent with changing climate, establishing enabling policy environment towards farmers, forecasting and managing early warning system, building capacity on adaptation and mitigation to climate change, and exploring employment opportunities of the people on farming and non-farming disciplines (Shrestha, 2019). In fact, the SDG 17, particularly promotes partnerships between governments, civil society, the private sector, and

development partners to achieve the goals. As one of the SDGs main targets is to double smallholder productivity and incomes by 2030, as part of efforts to end hunger and achieve food security (SDG-2), the seed industry's role is deemed important.

3.5 Community Based Seed System

Community based seed system is informal or semi-formal and locally managed, whose core function is to preserve seeds for local use. Local communities are responsible to design and implement the CBSS to conserve, restore, revitalize, strengthen and improve local seeds. The CBSSs have emerged as part of the informal seed system to counteract the loss of locally adapted crop varieties through the development of collective management systems, which mainly concern with diversity, conservation, exchange, community and sovereignty (Koller et al., 2017). Community-based seed production schemes have initiated because farmers are constrained by lack of seeds in planting time due to two reasons (Bänziger, et al., 2004): i) Seed may be unavailable due to environmental factors (e.g., drought) or civil disturbances; and ii) Seed from the formal sector may be unavailable or of high prices. Community-based seed production includes: choice of crops and varieties; training of seed farmers; quality standardization; credit to seed producers; cleaning, packaging, and marketing of seed; and sustainability of seeds even in the crisis condition. The CBSS is imperative in enhancing farmers' access and control on seeds, as well as their contribution to the conservation and sustainable use of crop genetic diversity (Shrestha & Mulesa, 2011). The community seed bank system contributes for biodiversity conservation, and use of crop diversity for sustainable livelihoods and food security and to halt the loss of biodiversity (Clancy, 2014).

The CBSS, can be a modality for delivery of locally adapted quality seeds, if there is formal supports from the public sector for its improvement. It can provide good management practices with healthy seeds; means of crop diversification, introduction of improved and stress tolerant varieties; opportunities for market integration; and in-situ conservation of traditional varieties for major crops, minor crops, and neglected and underutilized species. In the developing economies and the global south, the CBSS has been instrumental in regaining, maintaining and increasing the control of farmers and local communities over seeds. It can also performs dynamic forms of cooperation among farmers and between farmers and others concerned

institutions in the conservation and sustainable use of agricultural biodiversity.

The farmers and communities have been practicing community level seed saving initiatives and exchange at the local level within the community since over ancient time. However there is dearth of scientific literatures on community seed system linking with biodiversity conservation and food security. So this paper explore more possibility to strengthen the CBSS for promoting biodiversity and improving food and nutrition security in the South Asia. This approach is the sustainable means of securing improved access to, and availability of, diverse, locally adapted crop varieties, and enhance related indigenous knowledge and skills in crop management, including seed selection, treatment, storage, multiplication, and distribution.

Walsh et al. (2015) suggested that CBSS could improve through: formal and farmer seed system linkage; implementing coherent activities transitioning into commercial entities; linking CBSS with publicly funded programs; strong collaboration between the public- commercial and civil society and NGOs. According to Thijssen et al. (2015), the **guiding principles that help for Integrated Seed Sector Development are**: i) Foster pluralism and build programs upon a diversity of seed systems; ii) Work according to the structure of the seed value chain; iii) Promote entrepreneurship and market orientation; iv) Recognize the relevance of informal seed systems; v) Facilitate interactions between informal and formal seed systems; vi) Recognize complementary roles of the public and private sector; vii) Support enabling and evolving policies for a dynamic sector; viii) Promote evidence-based seed sector innovation. The CBSS is an important strategy to increase farmers' access to diversified crop varieties, particularly the resource poor farmers, in rural areas by bridging the gap between formal and informal sectors (Maharjan & Khanal, 2015).

4. Seed Production, Replacement and Trade of Major Crops

The Seed Replacement Rate (SRR) is the percentage of improved quality seeds adopted by farmers replacing the traditional seed varieties. SRR for a particular crop is the percentage of seed planted that is certified, truthfully labelled or commercial seed (Khoury & Delve, 2018). The SRR is higher for of hybrid crops since farmers need to purchase seed every year because the seed is very different from the parents, while it is lower for self- pollinated crops like wheat, rice or legumes since the seed is genetically identical to the

parents and farmers can save and replant the harvested seeds. Though SRR can be a useful indicator for enhancing crop productivity, the important issue is whether farmers are using the best adapted varieties, how often they are buying new seeds rather than using their saved seeds from the previous season.

The SRR is very low in South Asian region, which differs by country and types of seeds. South Asian agriculture is suffering by low SRR rate; ranges from 10 to 30% (for example, Nepal 16%, and India 30%). Seed growth rate in India is as 12% compared to global growth of 6-7%. The majority of the farmers use seeds produced from their saved own farms, farmers to farmers exchange, and purchase from the local markets, which are not considered as improved seeds and not estimated in the SRR. Even if such types of seeds are improved with higher yields, these are not considered as improved seeds because they are neither registered nor released. The South Asia region is having low SRR due to: ineffective extension services; high cost of improved seeds; farmers habituated using traditional seeds saving at home/ self-retained seeds; poor distribution mechanism and geographical difficulties; low technology development; high risk of climate change and its effects; use of informal seeds by farmers, and non-availability of quality certified seeds.

In Afghanistan, farmers acquired seed from different sources such as from own saved seed, seed from other farmers, seed bought with cash in the local markets, seed obtained free of charge from relief agencies and seed obtained with credit from relief agencies (Kugbei, 2007). The author estimated that more than 90% of the seeds used by farmers from the domestic sources; about 48.8% of the farmers used seed from their own production, 39.4% from the local markets, 4.3% from other farmers, and rest of the seeds from the seed enterprise, NGOs, and other sources, more than half of the seeds used by the farmers was poor quality.

In Bangladesh, the seed deficit of major cereal and vegetable crops was estimated to be 26% as the seed requirement was 1,251,580 tonnes, while the supply was only 327,962 tonnes in 2017 (Siem Reap, 2017).

In India, commercial seed markets for hybrid seeds are well developed, but this needs efficient flow of information to farmers, effective regulation of unscrupulous traders, need for technological backstopping, developing partnerships with private and civil society organisations, and developing capacity at the local level (Singh et al., 2008).

In Maldives, seed production is desperately low and almost the farmers rely on imported hybrid varieties because of its higher yields. As a result, indigenous varieties are being lost that could have higher economic value in the future. For the future sustainability of the seed system, the government initiated the community owned seed approach in the country.

In Nepal, the SRR of rice is 18.42%, maize 15.44%, wheat 15.22%, lentil 8.6%, rapeseed 12.19%, and vegetable 75% (SQCC, 2019). The seed supplied from the formal sources (NARC, Government farm and Centre National Salt Trading Corporation and National seed Company) was estimated to be 16%, while it was 84% supplied from the informal sources—farmers' level and private company/ DISPRO, CBOs) (SQCC, 2019).

In Sri Lanka, the SRR of rice was 15% and the seed self-sufficiency ratio (SSR) is 100%, indicating that the country is producing seeds as required by the farmers, while the SRR for maize was 53% and SSR was 15% because of farmers use mostly the imported hybrid seeds (DOA, 2018). Sri Lanka is self-sufficient in soya bean, cow pea, black gram, finger millet, red onion, ground nut and ginger, however the SRR is still low (DOA, 2018). There is a large quantity of seeds imported by South Asian countries, especially hybrid seeds, which threaten the seed diversity and the seed sovereignty. Seed sovereignty is a natural driver of local seed development and maintenance of seed diversity. Hence, the seed demand is higher than the seed supply, while the seed replacement ratio is much lower, implied that technology advancement and adoption at the farmers' level is crucial for agricultural development in South Asia.

5. SAARC Seed Initiatives

In order to efficiently delivering the improved seeds to the smallholder farmers in the South Asian countries, SAARC Member States have initiated regional collaboration in the seed sector. Such multi-lateral collaboration are: i) SAARC Seed Bank in 2011; ii) Cooperation among Bangladesh, India, Nepal, and IRRI in seed sector Protocol of Discussion (POD) on 18-19 October 2014 in Kathmandu, Nepal; and iii) Siem Reap Protocol of Discussions (POD) on Cooperation between Bangladesh, Cambodia, India, Nepal, Sri Lanka, and IRRI in Seed Sector on 9-10 June 2017 in Siem Reap, Kingdom of Cambodia.

5.1 SAARC Seed Bank-2011

The Governments of the SAARC (South Asian Association for Regional Cooperation) Member States, comprising Afghanistan, Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan and Sri Lanka, at the Foreign/ International Ministerial level on 11 November 2011, agreed to secure seeds through establishing the SAARC Seed Bank (SARC, 2011). The agreement was made inspired by the directives of the Thirty-seventh session of the Standing Committee and Sixteenth SAARC Summit (*Thimphu, 28-29 April 2010*) for expeditious action on regional collaboration in the seed sector in mutual spirit and benefit and based on the principle of collective self-reliance. The main objectives of this agreement were: i) To provide regional support to national seed security efforts; address regional seed shortages through collective actions and foster inter-country partnerships; ii) To promote increase of SRR with appropriate varieties at a faster rate as far as possible so that the use of quality seeds for crop production can be ensured; and iii) To act as a regional seed security reserve for the Member States.

The major provisions of this agreement are: produce quality seeds and increase the SRR; develop common varieties in the Member States and share; framework for material transfer to operationalize the regional seed bank; maintaining Common Minimum Seed Quality Standard (CMQS); the reserve; procedure for the release of seed from the reserve; determination of price; institutional arrangements; and functions of the Board. The SAARC Seed Forum has also been established on 25 February 2010 by the SAC to facilitate the SAARC Seed Bank Agreements in promoting sustainable and coherent development of Seed System so that the farmers of the one country of the region can reap the benefit from the innovation of the other countries.

5.2 Framework of Material Transfer Agreement

The Material Transfer Agreement (MTA) has been established, under the SAARC Seed Bank Agreement 2011, with overwhelming objectives and guiding principles to: i) Facilitate supply/ exchange of seeds of common crop varieties among the Member Countries for the purpose of achieving food security in the region; ii) The Framework shall be performed in accordance with the existing law, regulations and guidelines of SAARC Member States and the International Treaty on Plant Genetic Resources for Food and Agriculture; and iii) A Format for Material Transfer Agreement shall be used to exchange materials amongst the Member States.

5.3 Cooperation on Seed Sector—Protocol of Discussion

In order to materialize the SAARC Seed Bank objectives, SAARC Member States, particularly Bangladesh, India, Nepal and IRRI made POD "Cooperation among Bangladesh, India, Nepal, and IRRI in seed sector Protocol of Discussion" on 18-19 October 2014 in Kathmandu, Nepal (SAARC, 2014). The POD was expected to directly provide benefits to the farmers of all the three countries by sharing the rice varieties released in one country for use by the farmers in other countries. The POD further emphasized that the development of collaborative project for joint varietal evaluation and release, and recognition of the Farmers' Participatory Varietal Selection (FPVS) data, generated by the scientist, as primary data for varietal release.

The scope of the POD has been widened in terms of coverage of the countries and more commodities added in the next POD 2017 (SAARC, 2017). The POD 2017 is called "Siem Reap Protocol of Discussions (POD)". The POD 2017 was signed by the Secretary of the SAARC Member States from Bangladesh, Cambodia (not SAARC Country), India, Nepal, Sri Lanka, and IRRI (Director General) on 9-10 June 2017 in Siem Reap, Kingdom of Cambodia. This is the Third POD and an output of the Second POD on 18th October 2014 in Kathmandu Nepal, and First POD held on 17th February 2013 in Dhaka, Bangladesh.

The POD 2017 agreed to extend both Dhaka (2013) and Kathmandu (2014) agreements, which are confined to rice, to other crops; including other cereals, pulses, oilseeds, vegetables (non-hybrid), sugarcane and fiber crops. These countries also agreed to recognize each other's seed certification systems and to accept the seed certified by one country in the same category. However, this POD didn't cover the movement of seeds of Genetically Modified Varieties.

6. Seed Policies and Farmers' Right in South Asia

6.1 Seed Policies

The farmers' right can be ensured by the provisions of the government policies. The SAARC Member States have implemented their seed policies, seed acts, rule and regulations, ordinates, directives, guidelines and procedures (Box 1).

Box 1. Seed policies

- Afghanistan: National Seed Policy 2005; Seed Act 2009.
- Bangladesh: National Seed Policy 1993; Seed Act 2018; Seed Rules 1998; and Hybrid Rice Variety Evaluation and Registration Procedures 2016.
- Bhutan: Seed Act 2000; Seed Rules and Regulation 2006 (amendment 2017).
- India: Seed Act 1966; Seed Development Policy 1988; National Seed Policy 2002; National Seed Plan 2006; Seed Rules and Protection of Plant Varieties & Farmers' Rights Act (PPV&FR) 2001.
- Nepal: Seed/food sovereignty in Constitution 2015; Seeds Act 1988 (amendment 2008); and Seeds Rules 2013; National Seed Policy 1999 and Seed vision 2013-2025.
- Pakistan: Seed Act 2015, National Seed Policy 2016, Seed (Truth-in-Labeling) Rules 1991; Plant Breeder Act 2016.
- Sri Lanka: National Seed Policy 1996; Seed Law 2003.

Farmers' contribution in the food system, livelihoods and poverty alleviation of the people in the world is invaluable, though it is not adequately recognized by the governments and the decision making agencies. However, a nominal incentive in terms of subsidized seeds, technology, and capacity building have been provided to the smallholder farmers. Meanwhile, the public resources for agriculture R&D is too low in South Asia, which is far behind its contribution to the Gross Domestic Product (GDP). Underinvestment in agricultural R&D in South Asian countries is considerable, and agricultural research staff is significantly less-qualified. Human resource capacity in agriculture R&D is further deteriorated due to losses of highly qualified senior staff—outmigration to seek the better opportunities, limited training opportunities, and an aging population of researchers, resulting in poor enforcement of farmers' right (Stads, 2019).

Empowering and engaging of private sector is crucial in promoting agriculture and securing farmers' rights through improving technology, increasing extension services, and providing support services including markets (inputs and outputs) and value chain development. More importantly, use of farmer produced seeds and saving and exchanging among the farmers in the community are important in promoting

biodiversity and eventually in contributing to food and nutrition security. However, the present governments in South Asia are not recognizing this contribution. The government therefore should implement the policy incentives for such traditional knowledge, skill and practices of on-farm saving and community exchanged seeds through policy, acts, rule and regulations, budget allocation along with necessary programs. Indeed, seed security and sovereignty right, seed saving and exchange, input availability, resource utilization and ownership, assurance of price of the products, and consumption of health and hygienic foods are the basic farmer's right that need to be protected and promoted for smallholder farmers.

6.2 Promoting Farmers' Rights

Farmers' Right on seed security, food security and food sovereignty is paramount for the prosperity of a nation. Around 75% of the worlds' poorest 1.2 billion people live in rural areas and they depend on farming in a small scale farms, such smallholder farmers play a crucial role in the development, maintenance and use of agricultural biodiversity (Posada, 2013). Promoting Farmers' Right is imperative in enabling farmers to maintain, develop, and utilize plant genetic diversity, and recognize them for their contribution to the global genetic pool and food security, which has considerable impact to end poverty and hunger in the marginalized and vulnerable communities.

6.2.1 Legislation for Farmers' Right in South Asia

The SAARC Member States have endorsed some policies, acts and regulations for promoting the Farmers' Right, which are as follows:

Afghanistan: National Seed Policy 2005; Seed Act 2009.

Bangladesh: Plant Varieties Act of Bangladesh 1998; Biodiversity and Community Knowledge Protection Act of Bangladesh; Seed Act 2018; Seed Rules 1998; National Seed Policy 1993; and Hybrid Rice Variety Evaluation and Registration Procedures, 2016.

Bhutan: Biodiversity Act 2003 with provisions for breeders and farmers' rights; Seed Act 2000; Seed Rules and Regulation 2006, 2017 (revised).

India: Protection of Plant Varieties and Farmers' Right Act 2001 (PVA); Biodiversity Bill 2002; Seed Development, 1988; National Seed Policy 2002; National Seed Plan 2005-06 and Seed Act 1966/Seed Rules.

Nepal: The Seed Act 1988 (with amendment in 2008); Protection of Plant Varieties and Farmers' Right draft Bill (2005); Agrobiodiversity Policy 2006 (revised in 2014); Agriculture Development Strategy (ADS) 2014; Inclusion of seed/food sovereignty in Constitution 2015 (Seeds Act 1988 amendment in 2008 and Seeds Rules 2013; National Seed Policy, 1999 and Seed vision 2013-2025).

Pakistan: Plant Breeders' Rights Ordinance 2000; Seed (Amendment) Act 2015; National Seed Policy 2016; Seed (Truth-in-Labeling) Rules 1991; Plant Breeder Act 2016.

Sri Lanka: Protection of New Plant Varieties (Breeders Rights) 2001; National Seed Policy 1996; Seed Law 2003.

6.2.2 South Asian Countries' Membership of International Policy Agreements

Intellectual Property Right and Farmers' Right have been compliances by the SAARC Member States in terms of Policy, Acts, Rules or Ordinance to foster the innovation and conservation of the genetic resources. Table 1 shows the compline with membership for some major multilateral agreements.

Table 1. South Asian countries' membership of international policy agreements

Countries	ITPGRA	CBD	Nagoya Protocol	WTO
Afghanistan	Yes	Yes	No	Yes
Bangladesh	Yes	Yes	No	Yes
Bhutan	Yes	Yes	Yes	Observer
India	Yes	Yes	Yes	Yes
Maldives	Yes	Yes	No	Yes
Nepal	Yes	Yes	No	Yes
Pakistan	Yes	Yes	Yes	Yes
Sri Lanka	No	Yes	No	Yes

Source: Gauchan (2016)

6.2.3 International Treaty on Plant Genetic Resources for Food and Agriculture

Recognizing the contribution of smallholders for food security and food sovereignty, the FAO of the United Nations declared the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), a legal

binding multilateral agreement, adopted in 2001 with 128 Contracting Parties, is the basic foundation of Farmers' Rights as related to plant genetic resources (FAO, 2009).

The ITPGRFA's Preamble affirmed that past, present and future contributions of farmers in all regions of the world, especially those in centers of origin and diversity, in conserving, improving and making available these resources, is the basis of Farmers' Rights. The Treaty affirmed that the rights recognized to save, use, exchange and sell farm-saved seed and other propagating material, and to participate in decision-making regarding, and in the fair and equitable sharing of the benefits arising from, the use of plant genetic resources for food and agriculture, are fundamental to the realization of Farmers' Rights.

The ITPGRFA is mainly emphasized on the conservation and sustainable use of plant genetic resources for food and agriculture; fair and equitable sharing of the benefits arising out of their use; promote the collection of plant genetic resources; promote in-situ conservation of wild crop relatives and wild plants; integrate into its agriculture and rural development policies and programs and cooperate with other Contracting Parties, and provide technical assistance to capacitate the farmers and concerned parties. The treaty recognizes the countries' sovereign rights over their plant genetic resources and provides authority to the national governments the responsibility to establish farmers' rights in line with the national needs (Gauchan & Upadhyaya, 2006).

6.2.4 United Nations Declaration on the Rights of Peasants and Other People Working in Rural Areas

The United Nations proclaimed "the United Nations Declaration on the Rights of Peasants and Other People Working in Rural Areas" on 20th November 2018 aiming to better protect the rights of all rural populations including peasants, indigenous peoples, fisher folk, and farm workers to improve living conditions, as well as to strengthen food sovereignty, the fight against climate change and the conservation of biodiversity (UN, 2019a).

The declaration is more focused on the peasants and other people working in rural areas have the right to determine and develop priorities and strategies to exercise their right to development (Article 3); provision of equal access to financial, agricultural credit and loans, marketing facilities, appropriate technology, and required supports; organize self-help groups,

associations and cooperatives in order to obtain equal access to economic activities; and management of land and natural resources (Article 4).

The declaration further emphasized on the access to relevant, transparent, timely and adequate information in a language and form and through means adequate to their cultural methods (Article 11); decent working opportunities (Article 13); the right to produce adequate food to be free from hunger (Article 15); accessed to the means of transportation and the processing, drying and storage facilities necessary for selling their products on local, national and regional markets at prices (Article 16); the right to the protection of traditional knowledge relevant to plant genetic resources for food and agriculture; right to equitably participate in sharing the benefits arising from the utilization of plant genetic resources; right to save, use, exchange and sell their farm-saved seed or propagating material; and right to maintain, control, protect and develop their own seeds and traditional knowledge (Article 19).

The Declaration therefore is imperative to protect and promote the Rights of peasants and the people working the rural areas. Farmers' Right helps to empower and encourage farmers to conserve local genetic resources; technologies; seed system—production, use, save, sale, exchange; and rights in natural resources management that could contribute for conserving agrobiodiversity and improving food and nutrition security.

6.2.5 United Nations Decade of Family Farming 2019-2028

The United Nations General Assembly declared a resolution in its 72nd session on May 27-29, 2019 proclaiming 2019-2028 as the "United Nations Decade of Family Farming" (UNDFF) (FAO & IFAD, 2019) to promote the family farmers' rights in sustainable development recognizing the pivotal role of family farmers in achieving "a world where diverse, healthy and sustainable food and agricultural systems flourish, where resilient rural and urban communities enjoy a high quality of life in dignity, equity, free from hunger and poverty". **The Seven Pillars** of UNDFF's Global Action Plan aimed to promote the family farmers' rights.

The 1st Pillar— more focused to create and strengthen international, national and local cooperation for promoting the rights and multifunctional role of family farming.

The 2nd Pillar— emphasized on ensuring the generational sustainability of family farming through enabling youth accessing land, other natural

resources, information, education, infrastructure and financial services, markets and policymaking processes related to farming.

The 3rd Pillar—support instruments and conducive actions for the achievement of women's rights and gender equality in food and agricultural production by reinforcing women's organizations, promoting self-empowerment, their own capacity development process and women's autonomy.

The 4th Pillar—strengthen family farmers' organizations and capacities to generate knowledge, represent farmers and provide inclusive services in the urban-rural communities.

The 5th Pillar—improve socio-economic inclusion, resilience and wellbeing of family farmers, rural households and communities.

The 6th Pillar—promote sustainability of family farming for climate-resilient food systems.

The 7th Pillar—strengthen the multidimensionality of family farming to promote social innovations contributing to territorial development and food systems that safeguard biodiversity, the environment and culture.

7. Challenges and Opportunities in Seed System & Farmers' Rights for Food Security

The smallholder farmers in the rural areas are frequently encountered with several seed related challenges, as seed is the foundation for agricultural production, which reduced the productivity and eventually effects the food and nutrition security in the South Asia region. The following issues, challenges and opportunities for seed system and farmers' food security are briefly discussed.

i) Right quality, right quantity, right time and right price—the quality seeds with affordable price should be available to the smallholder farmers in the planting time as per the quantity required by the farmers.

ii) Traditional seed varieties and local knowledge are disappearing because of the seed markets are controlled by limited giant multinational business companies. Thus, biodiversity conservation and improvement in traditional knowledge is crucial for food security.

iii) CBSS are encountering challenges to sustainable seed supply because of lack of infrastructure development for processing and storage of seeds, limited technology, climate change effects, and less quantity of seed production.

iv) CBSS are always facing challenges to compete with imported informal seeds, which provide risk and uncertainty of production.

v) The CBSS seeds are widely used, however it is informal, hence it is crucial to formulate policies to register and release them for their promotions.

vi) Promoting the Farmers Right to produce, save, storage, use, exchange and trade of seeds and genetic materials as per TRIPS, ITPGRFA, UN Declaration to Peasant's Right and UN Decade of Family Farming.

vii) Develop efficient seed value chain that reduces the cost and improve the quality standard of the seeds that could contribute to efficient ad sustainable delivery of seeds to the smallholder farmers.

viii) The seed system is directly linked with food security, hence, it needs to develop better performing quality seeds that could contribute to the food system.

8. Recommendations

Based on the discussion in the previous sections, the following recommendations are derived for strengthening the seed system and promoting the farmers' right in order to improve the food security in South Asia.

i) Community Based Seed Systems

- The government should recognize the CBSS and support in formulating essential policies, acts, rule and regulations for community seed banks and other community based seed production mechanisms.
- Community seed banks are the bridge between in situ and ex situ conservation. The CBSS should be linked with the in-situ practices and the National Gene Bank as per farmers' requirement and improving conservation, availability and management of locally adapted seed varieties.
- The Government should establish the CBSS at the local level and make networking with country and regional levels. Set up a Community

Biodiversity Management (CBM) Fund at each community seed bank and support with necessary policies and programs.

- The CBSS should be tied-up with crop insurance schemes that contributes to minimise the risk of the farmers and CBSS for production quality seeds and ensuring local food security.
- Provide technical, financial and governance supports from the National Gene Bank to the CBSS for conducting good management practices (e.g., diversity block, participatory seed exchanges, traditional seed (diversity) fairs, registration).
- The government should integrate community seed banks in the government's regular programs on agricultural biodiversity, participatory plant breeding and participatory variety selection for improving food security.
- Formalize the crop varieties produced and marketed by the community seed system to be registered, certified and released.

ii) Developing New Seed Varieties

Developing new seed varieties with high yielding, biotic and abiotic stress tolerance characteristics should be the highest priority of the governments and allocated adequate financial and technical supports in cooperation with CBSS, private sector seed companies and multinational seed companies.

iii) Promoting Farmers' Right

- The government should establish and strengthen the Farmers' Rights on the basis of the country's real backdrop, Country's Constitution, Policy, Act, Regional Treaty and International Commitment and Conventions.
- The Farmers' Right need to be consistent and in compliance with the convention and declaration of international bodies (for example, TRIPs—Agreement on Trade Related Aspects of Intellectual Property Right; ITPGRFA—International Treaty on Plant Genetic Resources for Food and Agriculture; United Nations Declaration on the Rights of Peasants and Other People Working in Rural Areas) and UN Decade of Family Farming.

iv) Seed Value Chain Development

The seed system, particularly the CBSS should be given prioritized incentives and support for improved and updated seed value chain development

linking production, processing, storage, packaging, labeling, standardization, certification, marketing and use.

v) Capacity Building

Capacity building of the Agricultural Research Institutions and associated staffs, farmers, and stakeholders on technical and governance system in establishing CBSS and promoting efficient seed system is imperative. The Agricultural Research Institutes (ARIs) should focus their researches and innovations on farmers' demand, geography and climate, technical suitability, and preference of the consumers.

vi) Benefit Sharing Fund of the Plant Treaty

The CBSS should participate in the Benefit Sharing Fund of the Plant Treaty that will help in supporting community seed banks. The cost of conserving crop genetic diversity should be borne by the respective CBSS, but not by the resource poor farmers. Meanwhile, the CBSS should multiply and produce farmers' varieties for increased availability of locally adapted seeds.

vii) Efforts of Development Partners

The development partners, INGOs, NGOs, producers and family farmers' organizations and CBOs should focus their programs to promote community seed banks until governments have incorporated such banks in their formal systems.

viii) Seed System and Cross-Cutting

The seed system and the CBSS should be aligned with cross-cutting issues such as economic development, bio-diversity conservation, women and youth, and food and nutrition security.

ix) Future Smart Food

The CBSS should also link with Future Smart Food—promoting nutrition sensitive agriculture, and neglected underutilized nutrition rich crops could certainly improve the food and nutrition security of smallholder farmers and marginalized group of people in South Asia

9. Conclusions

Easy access of improved seeds to the smallholder farmers in the rural areas is the intertwining and enduring issue in the developing economies. This paper has been developed to assess and analyze the seed issue focusing on

the CBSS in South Asia, adopting consultation meetings and literature review. The smallholder farmers frequently encounter issues on quality standardization of seeds, quantity adequacy as required by farmers, affordability for the improved seeds, and availability of improved seeds during planting season. In order to cope with these challenges, CBSS has been an established approach where farmers produce the seeds, save at the community level, exchange among the farmers, and operate them-self; however, the CBSS has not been recognized by the respective governments. Strengthening the CBSS could have considerable impacts for conserving bio-diversity, resilient to climate change effects, income generation— that reduce the poverty and improve the food and nutrition security. South Asian nations have made good initiatives at the national and regional level through SAARC forum for strengthening formal seed system, but not the informal seed sector. There is not much progress in the implementation of seed exchange system that is important for food security and ensuring farmers rights of smallholder farmers. This paper therefore recommends some major policy interventions: strengthen the CBSS through government's policies and programs; promote farmers' right in seed saving, utilization, sale, and resource management under ITPGRFA, UN Declaration on the Rights of Peasants and Other People Working in Rural Areas and UN Decade of Family Farming; strengthen the seed cooperatives; aligning the private seed companies with CBSS and integrated efforts of the development partners and stakeholders.

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Chapter 2

Community Based Seed Systems for Agrobiodiversity and Resilient Farming of Smallholder Agriculture in South Asia

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Abstract

Community Based Seed System (CBSS) is emerging as a complementary approach to formal and informal seed systems for making seed system inclusive and dynamic to meet the diverse needs of smallholder farmers in marginal farming systems. The aims of this paper are to: i) Briefly outline the context, concept and features of CBSS; ii) Identify gaps and issues in CBSS; and iii) Provide options for improvement for agrobiodiversity and resilient farming of smallholder agriculture. The paper is developed from the literature review and experiences of working in this field for the last two decades. CBSS is a participatory farmer led holistic approach that deals with the needs and priorities of smallholder farmers in marginal regions using rich biodiversity in agriculture. With adequate support, it has potential to integrate informal and formal seed system as it deals with all of the crops and commodities of the locality including local and improved varieties and neglected and underutilized species (NUS) and future smart food crops. Despite the greater potential of CBSS, it is not a priority area for national governments and international development organizations for its research and development (R&D), seed quality improvement, use of rich agrobiodiversity for resilience and policy support for promotion of farmers' varieties. Therefore, recommendations are made to improve CBSS to make it more inclusive, pluralistic and dynamic through the use and promotion of rich agrobiodiversity, participatory crop improvement, community biodiversity management, community seed banks, and strategic partnership development with public and private sectors including policy support for their recognition and harmonization.

Keywords: Agrobiodiversity, CBSS, resilient farming, smallholders

1. Background

South Asia is one of the most densely populated areas, accounting for nearly one-fifth of the world's population with largest number of people living below the poverty line (SAARC, 2014). The region has high proportion of smallholder farmers with over 60% of them living in the rural areas. Due to predominance of smallholder farmers and rainfed farming system, seed system is poorly developed in South Asia. Literature shows that globally more than one billion hectare each year are planted to farm-saved seed with an estimated total value of around UD$ 7 billion at 2005 prices (Leask, 2005). FAO (2018) reports that informal seed system meets up to 90% of the seed requirement in developing countries. This is also true for South Asia, where small farmers and communities from the time immemorial have made unique, evolutionary and historical contributions to the conservation and development of genetic resources through on-farm saving, community exchange and recycling them for the next planting seasons (Gauchan, 2016). Over generations, farmers and local communities have developed traditional knowledge, skills and practices to grow, use and select adapted varieties, or their wild relatives, to meet various household, social, economic and cultural needs. In the process, they have inherited and practiced rich cultural heritage, traditional knowledge and collective actions for the management of agrobiodiversity that have helped to meet their food and nutrition security.

Access to timely availability of quality seed is extremely important for smallholder farmers for ensuring food and nutrition security, reducing poverty and making them resilient to changing climate. This is because seed is the basis of food security, conservation of biodiversity and vital input for agriculture. It is also a means for the delivery of new technologies and support services to rural areas. Use of quality seeds of better performing varieties is necessary to increase crop productivity and income of small farmers. Use of quality seeds also enhances efficiency and productivity of other key inputs such as fertilizers, irrigation and human labour. It is estimated that about 50% of the global increase in yields over the past 50 years has been derived from crop improvement (genetic progress) and seed quality, in addition to agronomic improvement and phytosanitary product uses (FAO, 2011). However, access to quality seed is a critical problem among smallholder farmers in developing countries. A recent study reveals that global seed companies are reaching only 10% of smallholder farmers in developing and emerging economies (Layzell, 2019). Therefore, a dynamic well-functioning inclusive seed system is essential that meets the needs of

diverse group of farmers including smallholder farmers in marginal farming systems for resilient farming, increasing and sustaining agricultural productivity growth and ensuring household food and nutrition security. The overarching goal of a dynamic functional seed system is to ensure that seeds are available and accessible to all end users, notably smallholder farmers, in sufficient quantity, quality and diversity to produce sufficient nutritious food in a sustainable way for the household itself, other consumers, or both (Bioversity International, 2017).

In this context, ensuring smallholder farmers' access to quality seed can only be achieved through a viable, dynamic and holistic seed system that can source out new diversity, multiply, market and promote use of quality seeds timely and efficiently in affordable price. However, national seed systems in South Asia are unable to meet farmers' needs in supplying quality seed of improved varieties at right time in affordable prices. Most smallholder farmers particularly in rainfed risk prone environments, regularly resort to low quality seeds and know-how in seed production, conservation and diffusion. With globalization, urbanization and increasing migration of rural youth to urban areas and overseas including impact of climate change, the current seed system is not being effective and dynamic to supply quality and diverse seeds to smallholder farmers, particularly in marginal environments timely in affordable prices. This is particularly true for traditional and underutilized crops and local varieties as the current conventional seed systems are not being able to provide required quality seeds and desirable varieties. Furthermore, due to the prevailing focus of centralized formal seed system and limited priority given in the local and diverse community based seed systems with resilience and adaptation, presently information and importance of community-based mechanisms of seed system is limited. Hence, there is a need of strengthening and promoting community based seed system that integrate formal and informal system to make seed system more dynamic, holistic and functional to serve the needs of smallholder farmers as well as other diverse actors in the seed value chain.

This paper aims to provide importance of community based seed system (CBSS) for agrobiodiversity and resilient farming for small holder farmers in South Asia. The paper first provides typology of seed system and concept and context of community based seed system. This is followed by key sectors and actors in seed business with specific features of community based seed system in comparison with public and private sector led seed business. A brief outline is made highlighting key gaps and issues with options for the

improvement of community based seed system. Finally, conclusions and recommendations are presented with special emphasis given to strengthen and promote community based seed system in South Asia.

2. Typology of Seed System

Seed system is one of the most vital components of agricultural system that involves activities associated with seed production, multiplication, processing and marketing to ultimate seed use by farmers. In general, seed system is composed of mainly two types; formal seed system and informal seed system (Figure 1). Considering inability of these two systems to meet seed needs to diverse groups and farming systems, recently, integrated seed system has been emerging in the literature as a complementary system to make the seed system more holistic and pluralistic. They are briefly outlined below:

2.1 Formal Seed System

The formal seed system is characterized by an institutionally organized production and distribution of improved varieties using officially defined quality assurance mechanism. They are predominantly embedded into large-scale, high-input agricultural production schemes with advanced mechanization in which the principles of the market are the paradigm (Louwaars & de Boef, 2012). The focus of formal seed system is mainly for major food staples, cash crops and their high yielding varieties. This facilitates for the production of uniform crops and varieties in large schemes and helps to meet consumer demands with regard to product prices and quality. Scientifically supported plant breeding and the aligned commercialization of the seed market contributed to formal seed system that focuses on few homogeneous crop varieties. Hence, agrobiodiversity of formal seed system is very much low with low resilience to changing climate, natural disasters and epidemics.

2.2 Informal Seed System

The informal seed system, often referred to as farmers' seed system, is characterized by traditional system of saving, production, exchange and management of seeds by farmers and communities to meet their seed requirements for subsequent planting. The majority of small-scale and subsistence oriented farmers do rely on informal seed system operating in low potential areas where complex environmental stresses challenge

agricultural production. In developing countries, it is estimated that up to 90% of all seeds planted are provided by informal seed system and it serves as an important safety net/ or coping mechanisms during the time of disasters and conflicts (FAO, 2018). Informal seed systems are established in the community according to the principles of meeting local food security and subsistence needs.

In this system, farmers have no or little access to formal institutions and mostly operate far from the effective implementation of policies and laws. Informal seed system is central to the conservation of biodiversity in smallholder production systems and only sources of neglected and underutilized species (NUS), that are important for food security and nutrition of smallholder farmers (Gill et al., 2013).

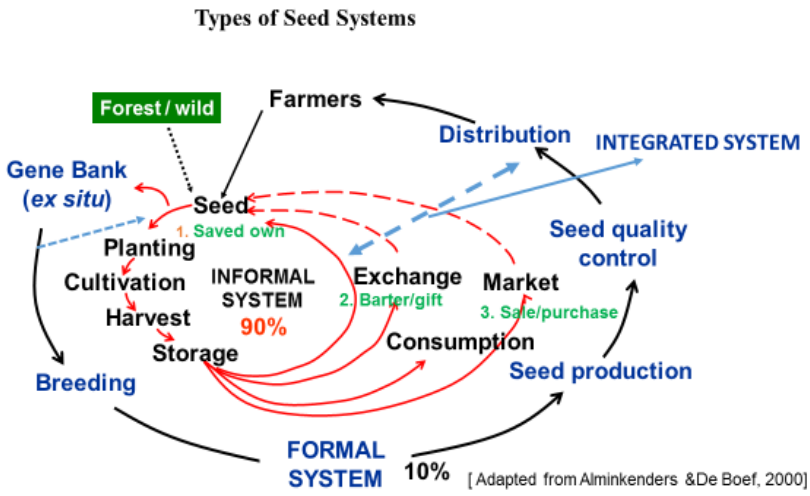

Figure 1. Types of seed systems, Formal, Informal and Integrated Seed System

2.3 Integrated Seed System

Recently, integrated seed system is increasingly being focused in the literature due to its holistic and pluralistic nature. This integrated seed system (Figure 1 with dotted line) recognizes the co-existence, evolution and importance of the formal and informal systems and looks for opportunities and options to improve them both by recognizing and supporting integrations (Louwaars & de Boef, 2012). Community based seed systems fall either in purely informal system or in semiformal system with some quality assurance activities. With its improvement and support from formal sector agencies, CBSS can support integration of informal and formal seed system

for the development of holistic and dynamic seed system that meet the needs of diverse group of farmers and stakeholders for increased farm productivity, income and increased resilience of the farming systems in the face of changing climate and market requirements.

3. Concept and Context of Community Based Seed System

Community based seed system (CBSS) includes diverse community based approaches for collective seed production, local seed exchange, marketing and use at the community level. It is participatory farmer-led approach for systematically planning and executing interventions towards promoting farmers' seed security and seed sovereignty (PLUM, 2016). The CBSS is complementary to the informal and conventional formal seed system. It aims to perfectly integrate the strengths and opportunities in both the conventional and the traditional seed systems and to enable traditional farmers meet their seed requirements by improving their know-how for addressing basic seed production and quality constraints (Beye et al., 2009). The main pillars of the CBSS are farmers' organizations that involve group of farmers and other Community Based Organizations (CBOs) such as cooperatives, community based seed producer groups, community seed banks, seed village groups and self-help groups. They can be broadly of both legally organized farmers' organization such as cooperatives or loosely organized informal groups such as farmers' groups, self-help groups etc. Greater crop diversification, better quality seeds and the introduction of new varieties increases genetic diversity and contribute to the viability of CBSS (FAO & ICRISAT, 2015). In the CBSS, the responsibilities are given collectively to farming communities and to certain innovative farmers as focal points for farmers' organizations to produce and market quality seed for supply to the local community and beyond.

With the liberalization and globalization, the community led approach of seed production and supply began with the experimentation of various seed and crop improvement related donor funded projects and Civil Society Organizations (CSOs) that are initiated in early 1990s in South Asia. Later, public sector organizations also gradually accepted and integrated these in their programs. For strengthening CBSS with improving agrobiodiversity and resilience of the system, recently Community Biodiversity Management (CBM) approaches are being promoted. It includes diverse community-based participatory approaches ranging from community-based agrobiodiversity fairs, diversity field schools, diversity blocks and diversity

kits to Community Seed Bank (CSB), CBM trust fund, participatory plant breeding, participatory seed networks and value addition and marketing (Sthapit et al., 2006; de Boef et al., 2013). Linkage of community seed banks with formal sector agency such as national gene bank can help recover and restore diversity and strengthen local community based seed system in the aftermath of the disaster such as mega earthquake of 2015 in Nepal (Gauchan et al., 2016).

4. Sectors and Features of Community Based Seed System

4.1 Sectors and Actors in Seed Business

Globally including in South Asia there are three dominant sectors in seed business namely public, private and community led seed system (Figure 2). These include: i) Public sector led by national agricultural research and extension system (NARES) and government supported national and state seed companies; ii) Private sector dominated by private seed companies, seed dealers and traders; and iii) Community sector represented by farmers and Community Based Organizations (CBOs) such as farmers' groups, cooperatives and community seed banks (Gauchan et al., 2014). The ultimate aim of these sectors and actors are to meet the quality seed needs of farmers in time at affordable price.

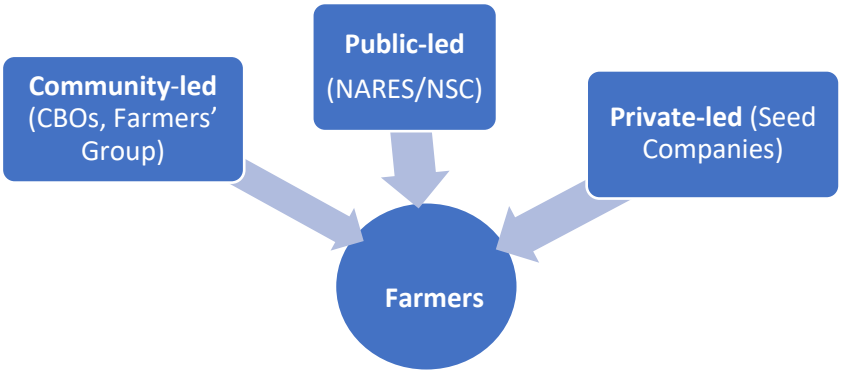

Figure 2. Key sectors and actors in seed business

Public sector agency such as National Research and Extension System (NARES) represented by national research organizations and public universities have been playing dominant role in variety development, maintenance and breeder seed production, while private sector represented by seed companies, dealers and retailers in multiplication and marketing of seeds to farmers and communities. Community led seed sector is emerging

recently with the participation of CBOs, NGOs and farmers' organizations. Community sector is mainly engaged in seed multiplication, marketing and maintenance of seeds for local community needs through collective actions (Gauchan et al., 2020). They receive source seeds either from public or private sector for their seed business. Farmers are the ultimate users of the seeds produced, multiplied and marketed by different actors and organizations. The prime objective of seed business for private seed enterprises (seed companies, seed dealers, retailers) is profit motive, while for community enterprises, it is for local self-sufficiency, local farm productivity and community collective benefits. For the public enterprises, it is mainly for service oriented and targeted to meet the national goal of seed sufficiency, food security and agricultural productivity.

4.2 Features of Public, Private and Community Sectors

The major comparative features of public, private and community sectors is presented in Figure 3. Despite important role played by the public sector in variety development, maintenance and source seed production, they are inflexible in operations to meet the needs of smallholder farmers in rainfed and other marginal risk prone farming systems (Gauchan et al., 2014; Gauchan, 2017).

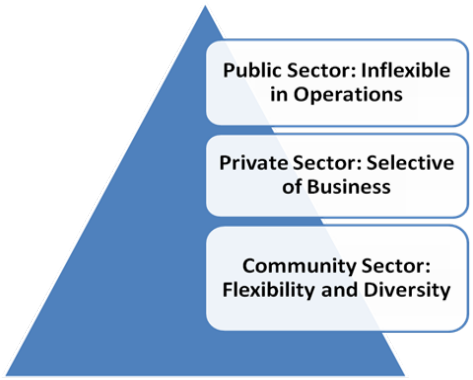

Figure 3. Comparative feature of public, private and community sectors

Public sector organizations are mainly focused on research, extension and marketing of officially released high yielding improved varieties. On the other hand, private sector actors are selective in business of commercial crops, high yielding varieties and hybrids that have high profit margin such as cash crops and hybrids of major staples. Presently both public and private sectors are not focusing their research, multiplication and marketing of seeds of local adapted farmers' varieties and those of underutilized crops that are

not officially released or registered. Among three dominant sectors (public, private and community) in seed business, community sector has special feature to meet the needs of smallholder farmers in marginal farming system as they provide flexibility and diversity in the local seed system (Gauchan et al., 2014). They produce, multiply and market the seeds of both local and improved varieties as per the local community productivity and cultural needs. The system often promotes community seed exchanges for local seed self-sufficiency and increased farm productivity as well as for increased resilience to sustain biodiversity and improve livelihoods. Therefore, community based seed system is preferred to private or public led seed model in the marginal farming system as CBSS has flexibility, diversity and resilience to reach remote rural smallholder farmers, where presence of public and private sectors' is inadequate or absent. A comparative strength and features of community, public and private seed sectors based on their key objectives and nature of seed business activities are briefly outline in Table 1.

Table 1. Key strength and features of community, private and public sectors

Strength	**Community Based Enterprise**	**Private Sector (Seed Companies)**	**Public R & D Organizations**
Seed business objectives	Service motive	Profit motive	Service oriented
Seed production scale	Small to medium	Medium-large	Medium-large
Seed exchange & information flow	High	Low	Low
Long distance sell & dispersion area	Low	High	High
Marketing skills	Low	High	Low- moderate
Risk taking	Low	High	Moderate
Decision making	Slow	Quick	Moderate
Diversity of varieties produced/marketed	More	Few	Few
Varietal choice and adaptation	High	Low	Low
Maintenance of crop biodiversity	High	Low	Low
Benefit to small farmers	High	Low	Low

Source: Gauchan et al. (2014)

Since private sector focus is on high value low volume seeds and economic volume of production and marketing to gain profit margin, they have no incentives to serve the needs of diverse location specific seed needs of heterogeneous farming systems (Gauchan, 2019). Similarly, public sector presence is also limited in remote rural regions of heterogeneous farming system due to infrastructural, human resources and budgetary constraints to carry out research, multiplication and supply of seeds of diverse crops, varieties and information needs of smallholder farmers. Community seed enterprises normally have higher varietal diversity produced and marketed with higher choice of varietal options and on-farm crop diversity. Smallholder farmers perceive more benefit from the community based enterprise as they can easily access seed from the community based seed system at the desired time in affordable price. Seed exchange and information flow among farmers and communities through community based enterprises is also higher as compared to public or private led seed business model. Therefore, CBSS is important to meet the diverse needs of smallholder farmers in marginal farming system and supply seeds of crops, varieties and seed classes that are not often supplied by private and public sector organizations. However, they need strong technical and managerial support from formal sector organizations to build their knowledge, skills and capacity to adequately produce, market and maintain the quality seeds of diverse crop varieties. Special support from public or private sector organizations is needed to maintain quality assurance services including support in truthful labeling, branding and marketing. Since seed business of CBSS vary by the locations and the type of community organizations (e.g. community seed banks, cooperatives or farmers groups), there is no specific recommended framework for CBSS business. Moreover, the sustainability of CBSS is not based on sole commercial considerations but also on governance factors such as leadership, business planning, sharing of risk and linkage with public and private sector institutions.

5. Current Gaps and Issues for Strengthening CBSS

At present, both formal and informal seed systems are not meeting seed needs of diverse group of farmers and seed actors, particularly in marginal risk prone farming systems due to absence of an efficiently functioning robust and pluralistic seed system. A formal institutionalized seed system is not adequately meeting seed needs, particularly for many of the underutilized crops and agricultural commodities, of small farmers in

remote areas and also (Gauchan, 2019). On the other hand, farmers' local seed system, which still dominates in developing countries is under severe stress from climate change, loss of agrobiodiversity, youth outmigration and *ad hoc* commercialization with modern varieties (MVs) and exotic crops. Inadequate access to quality seeds of wide range of choice varieties suited to diverse production systems limits choices to farmers and consequently limits their ability to cope with shocks and risks related to climate change, pests and diseases including their ability to fulfil changing market preferences. The major gaps and issues are briefly outlined below.

5.1 Low Priority for Minor Crops and Marginal Regions

Presently, the formal seed system in South Asia is dominated by major cereals and modern varieties of rice, maize and wheat in market accessible areas, where formal sector agencies are focusing their seed production, supply and quality regulation. Seed sector development is very much limited in locally adapted varieties of diverse crops including neglected and underutilized species and future smart crop species, where community based seed system prevails, particularly among smallholder farmers in marginal farming regions (rainfed and mountain environments). Informal community based seed system is dominant in minor crops as well as for local farmers' varieties of major crops in marginal regions where up to 90% of seed requirements are met by farm produced and community exchanged seeds. Participation of public R&D agencies and private sectors are limited in marginal regions and those for minor or NUS crop. National policies and programs including public education, research and extension systems have not given due emphasis for strengthening community based system with adequate technologies, subsidies and technical support services to link with formal seed system. Research and development in the management and use of agrobiodiversity and resilient farming to strengthen community based seed system is limited. Assessment, evaluation and documentation of local agrobiodiversity for functional traits and their use in crop improvement through participatory plant breeding and value chain development is limited.

5.2 Poor Quality Assurance Services

About three-fourth of the seeds used in South Asia is met informally through farmers own saving and community exchanges. However, the quality of seeds available and used are poor. There is practically no way and

mechanisms to monitor and ensure the quality of the informal system in the rural areas (Gauchan, 2019). Ineffective traditional seed storage structures and poor facilities in the informal system make seed quality and viability poor. Furthermore, formal sector seed quality assurance services are also not available for NUS crops and local varieties particularly in rural marginal farming systems. Since, most of seeds produced and marketed from CBSS are from informal system without registration and certification, commercial marketing of these seeds is illegal, hindering formal benefit sharing with the local communities. Similarly, the capacity of the CBOs to implement effectively the required quality assurance services in the remote rural marginal farming systems is poor.

5.3 Loss of Agrobiodiversity for Resilient Seed System and Farming

With commercialization, youth outmigration and changes in food culture, South Asia risks losing unique local crop diversity in the community based seed system through replacement by exotic modern varieties, hybrids and land use changes. Recently the trend of agricultural biodiversity is shrinking fast and humanity is losing cost effective options to deal with global challenges. About 75% of the genetic diversity has been already lost in the last three decades of agricultural development (FAO, 2010). Seed and food diversity is declining rapidly due to homogenization of production system and loss of informal seed system resulting in over-reliance on a handful of crops and commodities for food and nutrition security. Loss of agrobiodiversity and deterioration of community based seed system threatens food security, family nutrition and income as well as loss of industrial raw materials, medical drugs and ecosystem services. Loss of biodiversity also reduces the potential gene pool available for breeding new or improved crops, trees and livestock consequently making agriculture risky and reducing future innovation in agriculture. As a result, it has reduced the resilience of resource-poor farmers in the face of changing climate and market.

5.4 Inadequate Capacity and Institutional Support

CBSS requires collective action of the farmers and communities with certain locally defined rules and norms. This requires local capacity and external support for social mobilization and technical support in the organization of group of farmers and communities. However currently, many of the rural areas in marginal farming system lack adequate social and technical capacity

to organize in groups for collective action on production, marketing and maintenance of quality seeds of the required quantity of desired crop variety seeds. Recently, community seed banks and community based seed producer groups are emerging as local institutions for meeting local seed security, farmers' rights and access and benefit sharing (Gauchan et al., 2018). These community based institutions also lack adequate capacity in business planning, market information, knowledge and networks and policy support for efficient and timely production and marketing of quality seeds. Since many of these institutions are supported by short term donor funded projects and remains phased out after the end of the project, their sustainability is questioned. Thus, the most challenging aspect of community seed banks is its sustainability with its legal identify, financial viability, effective operational mechanisms and community empowerment (Vernooy et al., 2015).

5.5 Policy Gaps and Issues for CBSS

Many countries of South Asia lack a clear framework and legislation in place for protection of plant varieties and farmers' rights (Gauchan, 2016) including sustainable management of rich genetic resources that are useful for strengthening community based seed system. Absence of legislation on access and benefit sharing and farmers' rights discourage farmers and local communities to conserve, maintain and promote the use of local crop genetic resources for strengthening community based seed system. Similarly, present seed policy and regulations are not very much friendly and supportive for the registration and release of farmers' varieties that are essential for making CBSS flexible and resilient. There is a lack of incentives for breeders, farmers and private sector seed entrepreneurs to use effectively and continue managing rich genetic resources to develop, promote and use quality assured seed varieties. Furthermore, small and poor farmers have limited or almost non-existent access to credit and seed insurance schemes to minimize risks in seed production and marketing. There is also lack of harmonization of seed policies among South Asian countries responsive to latest international and national seed policy developments. However, recently some initiatives have been made for the smallholder farmers to access improved seed varieties released elsewhere in the South Asia region through effective implementation mechanism of SAARC seed bank, SAARC seed bank information system, SAARC seed forum, and seeds without borders among the South Asian countries (Shrestha & Thapa, 2019).

6. Options for Improvement

Effective seed systems provide the necessary mechanisms for access and exchange of seeds and planting materials needed by smallholder farmers for supporting maintenance of diversity of both improved and locally adapted varieties. The process should support the genetic processes for evolution and adaptation of resilience crop varieties. Traditional informal seed system may need improvement in terms of the phytosanitary quality of the seeds, and seed storage from season to season, or for longer periods. Similarly, formal institutionalized seed system needs to be improved with the addition of diversity of crop varieties for diverse group of smallholder farmers and increased adaptability and resilience to risk prone marginal environments. The vast agroecological and farming system diversity and rich biodiversity exist in South Asia offer unique comparative advantage to produce under natural conditions, a range of high-quality seeds of crops and varieties for both local needs and export markets. Additional considerations that add advantage in South Asia for CBSS include large proportion of rainfed risk prone farming system and high proportion of informal seed system. Furthermore, the current economic environment, seed policy and legislation also support the role of community based seed system. Some of the suggested options for improvement in CBSS is briefly outlined below.

6.1 Agrobiodiversity for Resilient CBSS

Seeds are the major part of biodiversity that contribute to feed the ever increasing population. Seeds are self-replicating and a resource which farmers can own and control to adapt to their needs. The capacity of seeds to cope with adverse conditions, such as due to climate change, disaster or pest epidemics is based on these properties (Louwaars & de Boef, 2012). The genes in the seeds largely determine how the crop will develop and adapt to the local ecosystem, pests and diseases, as well as determining the food's nutritional value, cooking time and distinct taste (Almekinders & Louwaars, 2000). Agrobiodiversity offers huge potentiality for strengthening resilient seed system for food and nutrition security by exploiting diverse gene pools for nutrition, climate resilience and other traits of economic importance.

In the vulnerable risk prone farming systems, diverse variety seeds have the resilience to adapt to changing climate and capacity to support ecosystem services in the face of changing biotic and abiotic stresses by providing increased numbers of functional traits and facilitative interactions for pest, disease and pollinators. The adoption of appropriate climate smart

agriculture approach consisting of developing stress tolerant and high yielding crop varieties, developing innovative technologies in consistent with changing climate, enabling policy environment towards farmers, and building capacity on adaptation and mitigation to climate change could reduce the effects of climate change (Shrestha, 2019). Improving availability and use of agrobiodiversity makes farming system resilient for increased and sustained productivity in the context of adaptation to climate change, disasters and improved nutrition. Diverse seeds derived from agrobiodiversity are needed to support the diversification of agriculture, which in turn may contribute to more diverse diets for nutrition security. An important element to create space for agrobiodiversity in seed systems is client orientation in seed innovation. Bringing diverse conditions, needs and preferences of clients into focus is important to ensure that innovation responds to the specific challenges of sustainable food systems (Bioversity International, 2017). Community based system is the central point to conservation of biodiversity in smallholder agriculture. In this milieu, access to seed diversity with diverse genetic resources bases is important to make CBSS resilient to vulnerability of the production system brought by climate change, natural disaster and political conflicts. Therefore, community based system is considered an approach to facilitate access, manage and promote agrobiodiversity for improved resilience of smallholder farming system and enhancing food and nutrition security of growing population.

6.2 Mainstreaming Community Biodiversity Management

Since the beginning of 1990s, national governments and international organizations globally including in South Asia have piloted and promoted some of the good practices for CBSS and CBM to promote local seed security and support conservation and use of agrobiodiversity. CBM is a community-based participatory approach to strengthen the community's capacity through the management of their agrobiodiversity and own knowledge based systems (Sthapit et al., 2006; de Boet et al., 2013). It helps to identify, conserve, add value and improve the access of knowledge and information for the management of local agrobiodiversity. The approach is community-centered, strengthens local decision making process and emphasizes local governance in the conservation and utilization of community biodiversity resources. CBM include diverse community-based participatory approaches ranging from community seed banks to participatory plant breeding, participatory sourcing and deployment, participatory seed exchange, seed networks, diversity based farmers field schools, CBM fund and biodiversity

fairs including market linkage and value addition (Sthapit & Gauchan, 2008; de Boef et al., 2013; Joshi et al., 2020). Many of these good practices of CBM that support resilience and diversity of community seed system are to be mainstreamed at the policy, plans, institutions and program level. Mobilization and strengthening the capacity of farmers groups, cooperatives, community seed banks and local self-help groups are important in this process for genetic resource management, access and exchange of seed diversity and strengthening resilient community based seed system. This will require proactive role of key actors of the seed system to make it functional, dynamic and holistic. The management and sustainable use of agrobiodiversity at the community level are important to sustain the livelihoods of poor communities who practice traditional farming systems and who live in harsh, often marginal, environments (Jarvis et al., 2016). Therefore, agrobiodiversity has potential to support and strengthen community based seed system for resilience by promoting CBM approaches and good practices.

6.3 Promotion and Strengthening Community Seed Banks

Strengthening community based seed system, through community-based approach such as Community Seed Banks (CSBs), community seed producer groups, and village seed schemes are critical for not only enhancing access to seeds of locally adapted varieties to farming communities but also conserving agrobiodiversity, improving households' resilience to climate change and supporting livelihoods of smallholder farmers. Therefore, an effective and sustainable community based seed systems can help improve the livelihoods of small farmers and benefit consumers as well, serving as an important element in strategies for agricultural development and poverty reduction (Minot, 2006).

CSB is evolving community based approach globally that can increase access to seed diversity and crop diversity on farms for improving resilience of smallholders' agriculture. CSB is defined as a community-based effort to conserve and use both local and improved varieties for ensuring food security and improving the livelihoods of farmers (Vernooy et al., 2015). The goal of a CSB is to increase local seed and food security and contribute to genetic diversity. It can offers storage facilities for good quality local seed varieties and facilitate seed exchange and seed saving at the local level for smallholders' food security and adaptation to changing climate (Shrestha et al., 2013; Vernooy et al., 2017). These are owned, controlled and governed by

local community and are relatively inexpensive as they operate employing simple low-cost storage technologies at the local level. Many of the CSBs currently act as an extension of farmers' informal seed systems, while some are acting as semi-formal system with engagement in production, maintenance and marketing of both local and improved varieties to self-sustain their conservation and management activities.

Recently, the CSB bank has been identified as a potential institution for facilitating Access and Benefit Sharing (ABS) mechanisms since it strengthens collective capacity of local communities to access and adopt new species and varieties as well as enhance availability of sources of information and inputs (Gauchan et al., 2018). In South Asia, particularly in Nepal, India, Bangladesh, farmers' groups, NGOs and CBOs are promoting and supporting community seed banks for local seed security, food security, farmers' livelihood and conservation of agrobiodiversity. However, in contrast to cooperatives, and officially promoted seed companies, they are not adequately recognised and does not receive adequate support and recognition from government and donor agencies (Vernooy et al., 2017; Gauchan, 2019). A growing evidence exists that CSBs give the greater priority to access of seeds of diverse crops and varieties including those of neglected and underutilized crop species particularly for resource poor farmers who are not able to save for their own needs or purchase them from the markets.

6.4 Participatory Crop Improvement

Participatory crop improvement is also a method to improve CBSS and conservation of agrobiodiversity by improving locally adapted farmer preferred varieties and their seed multiplication and supply. It is more suitable for marginal regions and underutilized local crops where formal sector plant breeding has not taken care of until recently. The most popular participatory methods of testing new varieties are Participatory Variety Selection (PVS) and other forms of Participatory Plant Breeding (PPB), including client-oriented breeding, grassroots breeding and evolutionary plant breeding. PVS is a powerful tool that helps to identify new varieties and deploy varietal options to farming system that farmers prefer and increase on-farm varietal biodiversity (Witcombe & Virk, 2001; Joshi et al., 2003). Similarly, PPB involves farmers and scientists from the early stages of plant breeding, (settings, crossing and use of segregating materials) increases farmers' access to seeds of new varieties for increased productivity and local

food security (Joshi & Witcombe, 1996). The PPB approach using farmers' traditional varieties (landraces) as the source of genetic material for crop improvement symbolizes a balance between the two goals of maintaining genetic diversity *in situ* and improving varieties according to the needs of farmers (Sthapit & Jarvis, 1999). Recently, Evolutionary Plant Breeding (EPB), a decentralized participatory method of crop improvement, is suggested in rainfed and marginal farming systems under changing climate for organic production and nutrition enhancement of consumers (Ceccarelli & Grando, 2019). Through these different methods of participatory crop improvement, the use of local varieties are being promoted in the communities, which contributes to stable food production and income, especially in marginal environments where the impact of modern varieties is limited. The power of participatory methods comes from their capacity to evaluate, source and deploy new diversity to many farmers, spreading it through an informal farmer-to-farmer seed exchange system (Sthapit et al., 2019). Participatory crop improvement methods are now commonly employed by formal sector organizations to improve local seed system of marginal risk prone farming system particularly in rainfed harsh mountain as well as drought, flood and salt prone environments.

6.5 Strengthening CBSS for Integration with Formal Seed System

The CBSS is essential to integrate and support seed needs of diverse crops, group of farmers and regions, particularly for the smallholders' food security by integrating both formal and informal seed systems. CBSS plays important role in this process as it has both informal and formal components of seed system dealing with local as well as improved crop varieties and diverse species including those of neglected and underutilized ones. However, currently, there are considerable diversity of community based seed systems and their standards. Local capacity building of communities as well as external support is needed to monitor quality assurance aspect of seeds maintained and marketed by community seed banks for their better business success. This can be possible through networking and building capacity of community based organizations such as farmers' groups, CSBs, cooperatives, self-help groups and local NGOs. Strengthening CBSS in terms of participatory crop improvement, CBM and seed business including quality assurance mechanism will support integration by linking with formal sector public and private institutions. Such an integrated seed system strengthens individual seed systems, whilst actively seeking opportunities for integration and complementarities between, formal and informal seed

system (Louwaars & de Boef, 2012). It also fosters the participation of diverse actors from diverse regions including smallholder farmers from marginal farming system to promote use of availability of quality seeds of better performing varieties, thereby contributing to food security and economic development. This will, however, require quality improvements in the informal seed systems and diversification of seed supply sources in formal system and fostering sustained linkages and integration between them (Gauchan, 2019). A strategic partnership of research, seed enterprise, government quality assurance services and informal sector institutions such as farmers' and community based organization is necessary to achieve this goal.

6.6 Policy Support and Recognition of Farmer-managed Seed Varieties

Farmers' managed local variety seeds are important component of community based seed system. Since, many of the local varieties are evolved locally, they are well adapted, climate resilient and provide diversity and flexibility to community based seed system. However, presently national seed policies and practices in many South Asian countries do not recognize and support the release and registration of these varieties for their promotion and commercialization. Furthermore, currently, national and international policies and regulatory frameworks are designed to support and protect the Intellectual Property Rights (IPR) of breeders in order to stimulate innovation and recoup investment to develop improved varieties and hybrids that can be legally protected as a new innovation and have better market demand. Presently, many of the South Asian countries (except India) have not officially enacted legislation to support and project farmers' rights to genetic resources (Gauchan, 2016) to support CBSS for strengthening local seed system and promoting resilience of agriculture. Hence, there is a need for policy and legislation formulation, enactment and recognition in regional and national framework for their protection and of the value and contribution of farmer varieties to food security and nutrition, livelihoods, biodiversity, and resilience to climate change. Awarding custodians and developing mechanism and process for creating incentives for conservation and use of traditional crop biodiversity can be good initiatives in this direction. The creation of an enabling policy environment for investment in seed regulatory framework, subsidy, support and incentives for production, marketing, and consumption of local crop diversity is also equally essential for strengthening community based seed system.

6.7 Partnership Modality Based on Comparative Advantage

Promoting the development of a strong, dynamic and sustainable seed sector in South Asia will require adoption of specific R&D partnership modality with a coordinated effort between the public, private and or community sectors, where the roles of each of the sector may differ across crops, value chains, production systems and stage of seed industry development. The R&D partnership modality needs to consider the current context and future development that requires use of integrated seed system linking both formal and informal system and use of market and non-market channels (Gauchan, 2019). The public sector has comparative advantage in variety development and maintenance, community sectors in seed production and multiplication, and private sector in strategic marketing. For subsistence marginal farming system with dominance of informal system, there is a need of partnership of community sector with public organization to source and supply quality seeds of choice varieties since private sector has presently no incentives to participate in this system. In relatively favorable semi-commercial or commercial system, partnership of community sector can be made with both public and private sectors. Private sectors may have some incentives in such system to engage in seed R&D with community sector, even though return from seed business may not be that profitable due to the need of engagement in local crop varieties and NUS crops that have low economic scale of seed demand. Public-private-community partnership is essential to capture synergy and utilize comparative advantage of each of the actor. In this context, in order to promote the integrated seed sector development, special emphasis should be given to strengthen public-sector breeding, supporting community sector seed multiplication and promoting private-sector marketing. The future development strategies need to consider this multiple partnership that requires use of integrated seed system linking both formal and informal system (Louwaars & de Boef, 2012).

7. Conclusions

Community based seed system is emerging as a complementary approach to formal and informal seed systems for making seed system inclusive and dynamic to meet the diverse needs of smallholder farmers in marginal farming systems. It is a participatory farmer led holistic approach that deals with the needs and priorities of smallholder farmers in marginal farming systems using rich biodiversity in agriculture. Development of an effective community based seed system is important that plays dynamic roles in

sourcing and deploying new diversity, facilitating timely access to seeds to smallholder farmers at affordable price and promoting seed production, marketing and use. With adequate support, it has potential to integrate informal and formal seed system by taking comparative advantages of both of the systems. Agrobiodiversity offers great potential for strengthening resilient community based seed system for food and nutrition security by exploiting diverse gene pools for nutrition, climate resilience and other traits of economic importance. CBSS is holistic and uses rich agrobiodiversity as it deals with all of the crops and commodities of the locality including local and improved varieties and neglected and underutilized species (NUS) and future smart food crops. Despite the greater potential of CBSS, it is not a priority for national governments and international funders for its R&D, seed quality improvement, use of rich agrobiodiversity for resilience and policy support for promotion of farmers' varieties. However, there is an increasing need to support CBSS from formal sector agencies to integrate formal and informal seed system to make seed system more inclusive, pluralistic and dynamic to serve the needs of diverse group of farmers and make smallholder farming system resilient in the changing climate and market needs. In this context, national governments in South Asia are suggested to make especial efforts to prioritize and promote community based seed system for agrobiodiversity and resilient farming of smallholder agriculture with right policies, programs and institutions.

8. Policy Recommendations

A great potential exists to increase crop productivity, income of smallholder farmers and improve resilience of the farming system in diverse environments by promoting community based seed system, integrating formal and informal seed systems and strengthening networks of existing seed actors. The creation of an enabling policy environment for investment in seed regulatory framework supportive to farmers' varieties and community based seed system and incentives for production, marketing, and consumption of local crop diversity is essential for strengthening community based seed system. Therefore, special emphasis is given to adopt following recommendations to strengthen and promote community based seed system in South Asia:

i) Improving seed quality and quality assurance services in community based seed system with capacity building of local community based

organizations and their enhanced linkages with the formal seed system.

ii) Promoting decentralized participatory crop improvement approaches (e.g. PPB, PVS, EPB) to select and improve farmers' crop varieties utilizing diverse genepools for increased productivity, adaptability and profitability in marginal farming systems.

iii) Mainstreaming good practices of community biodiversity management (CBM) practices for resilient farming systems in the context of climate change adaptation and changing market needs.

iv) Strengthening and promoting community seed banks and other community based institutions (e.g. community based seed producer groups, seed village schemes etc.) to conserve, produce, maintain and market locally adapted seed varieties in marginal farming systems.

v) Policy reform and harmonization to recognize, facilitate and support in the release, registration and promotion of farmers local varieties and creating their ownership rights to farmers and local communities.

vi) A clearly designed strategic public-private-community partnership modality that is inclusive and dynamic for the development of integrated resilient seed system to meet farmers' preferences and cope with the changing climate and market requirements.

These above recommendations are critical for strengthening and promoting community based seed system in South Asia, which will help to complement overall holistic seed system by supporting the livelihoods and resilience of the smallholder farmers in rainfed and risk prone environments.

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Chapter 3

Seed Exchange and Distribution Platform for SAARC Member States

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Abstract

Strengthening seed system in SAARC Member States remains a priority to achieve self-sufficiency in food and nutritional security. The opportunity in improving the seed sector is much wider, while the challenges continue to persist the development in this sector and require due attention with a holistic approach to generate income to seed growers and support marginal farmers in particular. As the small holder farmers are constrained by dearth of availability of quality seeds in the South Asia region, there is need for bilateral and multilateral efforts among the SAARC Member States and concerned stakeholders to strengthen seeds system in the region. This paper has been developed using secondary information and literature review, particularly the SAARC initiations on seed issue. SAARC has initiated some major efforts to strengthen the seed distribution and seed exchange mechanism among the Member States through SAARC Seed Bank, SAARC Seed Forum and Seed without Border. Regular consultation among Member States to improve the scope of intensifying the production and distribution of quality seeds is thus essential to effectively utilise the opportunity of seed bank and seed forum mechanism. Seed trade protocols need to be more efficient in order to flow of seeds among the Member States. The SAARC Seed Bank and SAARC Seed Forum could promote regional integration of seeds through sharing of genetic resources and technologies, and that eventually contribute to achieve the targets of the Sustainable Development Goals (SDGs).

Keywords: SAARC Seed bank, SAARC seed forum, seed exchange, seed systems

1. Introduction

South Asian region has one fourth (24.8%) of the global population, more than 65% people reside in rural areas and their main source of livelihoods is agriculture. South Asian agriculture continues to encounter major challenges such as the lack of technology for productivity improvement and value-chain efficiency, climate change, followed by the low investments in R&D, lack of human resources and infrastructure development (Shrestha & Thapa, 2019). The author argued that the productivity enhancement is a challenge to feed the growing population where varietal development with higher productivity and stress tolerance could be the main strategy in the region. Climate change in South Asia is one of the major challenges in agriculture that can be addressed through appropriate adoption of climate smart agriculture including adaptation and mitigation strategy (Shrestha, 2019). Due to changing climatic conditions in the past few decades, the region could lose 10-50% of the crop production probably by the end of the century (Gurung et al., 2017). Apparently with increasing population, the region faces challenge in meeting the food requirements and the demand for food has increased. Proper linkages need to be developed among private seed industry and public research institutions for developing new hybrids and facilitating quality hybrid seed access to farmers. The quality seed production that is linked to food production plays an important role to meet the demand for food (Varaprasad et al., 2019). Optimum use of inputs, particularly the seed is a prerequisite for increased productivity. The previous studies proved that quality seeds increased 20-25% yield of the crops. Use of improved seeds could enhance productivity and efficiency levels, increased profitability and profit efficiency in agriculture, and eventually that improve the food security and poverty eradication (Shrestha et al., 2016a; 2016b).

Quality seed production in the SAARC Member States helps to increase the productivity of food crops and eventually improve food & nutrition security and reduce poverty. The smallholder farmers, comprising more than 65%, are encountered by the lack of improved seeds in the SAARC region that reduced the productivity. In fact, there is huge potentiality of producing unique seed/varieties in different countries of the region because of rich in agro-biodiversity. Seed sufficiency differs among countries in the SAARC region; some of them are much deficient of quality seeds amidst others. Seed integration and policy harmonization among the SAARC countries is crucial to harness the opportunities for improving access of seeds to the smallholder

farming communities for ending poverty and hunger in the region (Shrestha & Thapa, 2019). In order to enhance or support the seed systems, seed exchange, quality seed production in SAARC Member States, seed platforms like SAARC seed bank and SAARC seed forum could play a vital role. However, the functioning of these platforms and delivery systems are to be smooth and effective in order to comply with the needs of the seed growers and farmers in South Asia.

In order to make accessibility of quality seeds to the smallholder farmers in the SAARC Member States, SAARC in collaboration with International Rice Research Institute (IRRI) initiated some major activities for strengthen the seed systems. This paper therefore analyse the provisions, problems and prospects of SAARC Seed Bank, SAARC Seed Information System, SAARC Seed without Border.

2. SAARC Seed Bank

The SAARC Seed Bank was established in the year 2011 with the agreement among eight Member States of SAARC region (SAARC, 2011). The Thirty-seventh session of the Standing Committee (Thimphu, 27 April 2010) agreed on establishment of a regional seed bank. SAARC Seed Bank ratification was made by member states of SAARC came into effect from the year 2016. The first SAARC Seed Bank (SSB) Governing Board meeting was held at Dhaka, Bangladesh in August 2016. Since the year 2016, the SSB took all necessary initiatives under the common agreement framework related to seed exchange and distribution within the Member States on a common platform and by conducting board meetings.

2.1 Provisions under SAARC Seed Bank

The following activities of common interest are strengthened under the SAARC Seed Bank.

- Regional level evaluation of the promising varieties and identification of common varieties and major crops.
- Regional level variety release of crops.
- Establish SAARC regional seed information systems.
- Formulation and adoption of common procedures and system for quality evaluation, export, import, quarantine, IPR regulations, material transfer agreement etc.

- Developing common minimum seed quality standards (CMSQS) for various crops of South Asian region.
- Strengthening formal and community based seed production.
- Establishment of nodal seed testing labs and International Seed Testing Association (ISTA) accredited labs.

Within the SAARC Seed Bank framework of agreement, the modalities of operationalization under Article IV was focused on sharing of common varieties of various crops. The modalities of operation under Article IV are listed below:

- Develop a list of common varieties of crops that needs to be reserved for conducting adaptive trials in the designated Agricultural Economic Zones (AEZs).
- Material Transfer Agreements (MTAs) need to be exercised and prepared for the purpose of varietal sharing.

To support the above activities, SAARC Agriculture Center (SAC) has published compiling the released varieties of cereals, pulses and oilseed in SAARC Region. SAARC Crop varietal information systems has been developed based on the information available in the published book that could help the SAARC Member States to exchange varieties under the agreement framework. The seed varieties and its quality maintenance are described under the Article V of the agreement. The modalities of operation under Article V are listed below:

- Develop a common minimum standard of seed quality that will improve productivity and increase profits.
- Develop a common Seed Standard and Certification System that will help to strengthen the seed systems.
- Harmonize seed acts and regulations that supports the quality seed development and procurement.
- Develop harmonized procedure on transgenic varieties.

As per the agreement, the Focal Point Representatives of SAARC Member States were assigned to send at least 2-3 designated mega varieties (Mega varieties are those released-with multiple biotic/abiotic stress tolerances in the past 5 years) to the Directorate of Seed Research (DoSR) at Mau in Uttar Pradesh state of India. The DoSR shall prepare trial kits and send those seeds to SAARC Member States for conducting the multi-location trials. The protocol is developed jointly by DoSR and SAARC Agriculture Center.

Thereafter, SAC explores to provide seed handling fund to DoSR and minimum support grant for experimentation. The adaptive trials were initiated by SAC in the region for vegetables (tomato, brinjal, okra, cucumber and pumpkin), cereals (rice), oilseeds (rapeseed, groundnut, sesame, soybean and safflower) and pulses (mung bean, lentils and black gram). Based on the minimum period of experimentation of at least two years preferably, the results obtained will help to choose the promising varieties and thereby could be designated for release as regional variety. To further facilitate sharing of potential crop varieties, exchange of results by the Member States and information on crop varieties may be possible when information systems are developed for the SAARC Member States. The seed trade protocols need to be more efficient in order to timely send and receive seed among the Member States.

2.2 SAARC Seed Bank: Seeds Access to Member States

SAARC Seed Bank provides an excellent platform to Member States for access to seed through designated focal points while keeping in loop the research institutions like NARS (National Agriculture Research Systems), extension agencies and thereby to help farmers and potential seed growers. Famers can conduct participatory trials to choose the right seed materials of specific varieties of crops that will suit the different agro-climatic conditions while providing optimum inputs for increased productivity. However, procedures outlined for receipt of the seed material can also be streamlined to minimise any time loss to reach out to marginal farmers. The seed bank initiative requires greater emphasis by Member States for provisioning of quality seed with subsidised rates and to procure seeds from respective source agencies in the minimum time possible to conduct participatory trials. Concerted efforts are thus required at all levels to achieve desired results and smooth functioning of the seed bank.

3. SAARC Seed Bank Information System

SAARC Seed Bank Information System (SSBIS) has been established by SAARC Agriculture Centre (SAC) and the required information can be available on SAC's website. SSBIS focusses on assessment of demand and supply of crop and variety wise seeds, assessment of most popular varieties, enable smooth and fair exchange and distribution of seeds and genetic resources. It acts as a regional security reserve of crop seeds to meet contingent situations, regional level introduction and testing of varieties in a

network mode involving the SAARC countries and harmonize procedures and system for material transfer, variety release, notification, certification, quarantine, Intellectual Property Rights (IPR), transgenic crops and related aspects.

The SSBIS will provide all necessary information about the seed availability of different crops and it is important that the Member States provides time to time updates on the availability of new germplasm, seed materials of crops. This will help to constantly include the latest information about the advanced seed materials and share the information with the respective Member States for access to the available material.

4. SAARC Seed Forum

The SAARC Seed Forum (SSF) was established on 25 February 2010 by the SAARC Agriculture Centre (SAC) as per recommendation of the regional workshop on "Quality Seed in SAARC Countries" held at New Delhi, India during 16-18 December, 2009. **The major objectives of the SAARC Seed Forum include:** i) To advocate and support development of harmonized and suitable policies and strategies and regulatory frameworks; ii) To help preparing action plan and pursuing of implementation for sustainable development of seed system of SAARC countries; iii) To act as a common platform to promote business among the countries of the region; and iv) To take up any other activities as may be necessary to fulfil the mandate.

The mandate of the SAARC Seed Forum is to promote sustainable and coherent development of seed system in the SAARC countries, as farmers in the region could benefit from the innovations of the other countries. Farmers will be able to have access to information and address any concerns to the focal points or local government agencies who are linked with seed development activities or who has access to evaluate or distribute new seed materials with farmers or seed growers.

In confidante to the aspirations and commitment of the SAARC Seed Forum, SAC continued to make it as a vibrant forum. This is in coherence to the mandate of the Centre for the SAARC Seed Bank, which could also benefit from such forum. Efforts have been made to decide the Nodal Points from the SAARC Member States for specific SAARC Seed Forum activities, especially to update on the constitution of the forum, memberships and to draw up the action plans.

With the seed platforms in place it would be easier and efficient to manage different levels of seed materials exchange between Member States while optimising the seed trade protocols in the region. The material transfer agreements helps to efficiently use and acknowledge the seed material performance in different agro-ecological zones in South Asia. However, necessary changes or updates can be made on mutual consent to improve and expedite seed material exchange within the Member States. SAARC seed forum helps to implement the sustainable seed system as well as draw necessary action plans that addresses the needs of the Member States.

Increased production of quality seeds and their timely distribution at affordable price or subsidized rates, enhancing the Seed Replacement Ratio (SRR) along with variety replacements can help in attaining desired food and nutrition intake among the population. Enhancing seed production through public-private partnerships can open new opportunities and help in income generation to the seed growers as well as potential community based seed growers in the region. Therefore the SAARC initiatives of seed bank and seed forum can be the key platforms for sustainability of seed in the SAARC Member States.

5. Seeds Without Borders

Considering the vital importance of sharing and accelerating the delivery of valuable rice germplasm among Asian countries, the International Rice Research Institute (IRRI) and the SAARC Agriculture Center (SAC) initiated the facilitation of harmonizing seed policies across Asia to enable crop varieties released by one country to benefit the farmers in another. This initiative is known as "Seeds without Borders" Agreement or Protocol. This agreement in principle provides access to new improved varieties of crops to the member countries very quickly with minimum investment on time and resources. Three Agreement Protocols (Dhaka Agreement 2013; Kathmandu Agreement 2014 and Siem Reap 2017) have been signed to facilitate the movement of seed varieties to member countries such as Bangladesh, Bhutan, India, Nepal, and Sri Lanka in SAARC countries and Cambodia and Myanmar from ASEAN countries.

In order to materialize and functioning these Protocols, SAARC Agriculture Centre (SAC) and IRRI organized a regional consultation meeting in 2019 on "Seeds without Borders" representing SAARC Member States to identify a permanent functional mechanism of Seeds without Borders framework. As

the outputs of the meeting**, ten following recommendations were endorsed to strengthen the Seeds without Border in South Asia**.

i) Seed without Border is a fast track mechanism of bilateral sharing of seeds and information using the mandatory requirement for material transfer between two countries.

ii) SAC was recommended to act as coordinating body for facilitating the "Seeds without Border" initiative.

iii) SAARC Seed Bank need to facilitate the exchange process of seeds and associated information among the SAARC Member States on Seeds without Border.

iv) SAARC Member States that are yet to join Seeds without Borders were requested to join the initiative.

v) SAARC Member States were requested to recommend nodal institution and nodal person to facilitate this initiative.

vi) SAARC Member States were requested to provide check list of documents (e.g. request letter, import permit, phytosanitary certificates, templates, SPS requirements, etc.) required for sharing seed varieties and information to SAC.

vii) Each SAARC Member State was requested to identify potential and popular crop varieties along with passport data including agronomic, agro-climatic (temperature, rainfall, day length, etc.), disease, insect pests and other relevant information to be shared with the Member States. The information to be placed at SAC web portal linked with the web sites of Member States.

viii) SAARC Member States were requested to share above mentioned information and SAC shares consolidated information before the end of 2019.

ix) Seeds receiving SAARC Member States were bound not to share the materials with the third country without prior consent of providing country.

x) A list of crop species covered by "Seeds without Border" should be prepared and shared with Member States.

Furthermore, further recommendations were made including regular consultation meetings need to be organized to review the progress and resolve the issues and challenges; SAC should play facilitating and

coordinating role; and all the Member States should comply and effective implementation of the 10 recommendations.

The SAARC Member States need to have strong willingness and commitments to implement the protocol on "Seeds without Border" and harvest mutual benefits by sharing the popular seed varieties among the countries.

6. Constraints and Challenges on SAARC Seed Initiatives

Some of the challenges related to seed initiatives are discussed below:

- Lack of awareness about the benefits and functioning of SAARC Seed Bank and Seed Forum, especially to potential seed growers in Member States.
- Seed related information updates are not easily available on regular basis to seed growers and marginal farmers.
- Lack of focussed capacity building measures on seed development in the region.
- Every Member State has their own policies and regulations on seeds and trade related issues that could hinder to materialize the Material Transfer Agreement and Seed without Border mechanism.

7. Recommendations

In order to effective implementation of the above mentioned SAARC initiatives and to achieve the set forth objectives, following recommendations are derived:

- Established Seed Bank and Seed Forum platforms need to be widely publicized in order to increase the access to the seed platforms, as well as to improve the seed production on sustainable basis.
- Functional linkages to be developed among private seed industries and public research institutions for developing and facilitating quality hybrid seed access to farmers.
- Regular updates on seed related information need to be provided by Member States to the database of Seed Bank and seed forum, especially related to the seed availability and access to improved seed materials.
- Capacity strengthening activities related to seed improvement are to be under taken on regular basis by the Member States through the available and established seed platforms for quality seed production and sustainable seed development.

- Harmonize the seed policy and trade policy of the Member States that could facilitate to smooth flow of seeds across the region.

8. Conclusions

The Seed Bank and Seed Forum initiatives of SAARC provide a necessary platform to continue to address the seed related aspects, especially for improving the quality seed production as well as providing access to quality seeds to marginal farmers and potential seed growers in South Asian region. There needs to be concerted efforts by the SAARC Member States to continue to deliver the necessary outputs of seed production under the framework of agreement using these established platforms to achieve food and nutritional security in the region. In order to smooth functioning of the Material Transform Agreement, the country specific policies need to be harmonized to expedite the flow of seeds across the region and that contribute to enhance the productivity of crops and eventually improve the food and nutrition security of the rural family farmers in South Asia.

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Chapter 4

Summary of First SAC-AFA Forum on CBSS Learning Exchange on Community Engagement on Seed Sovereignty for Resilient Agriculture in South Asia

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Abstract

The SAARC Agriculture Center (SAC), the Asian Farmers Association for Sustainable Rural Development (AFA) and the Action Aid Bangladesh (AAI) co-organized a workshop with the theme Learning Exchange on Community Engagement on Seed Sovereignty for Resilient Agriculture in South Asia, held May 19-21, 2018 at the RDA Compound in Bogura, Bangladesh. It brought together for the first time, 38 representatives from all member states of SAARC, and from farmers organizations and non-government organizations in five countries. The workshop was a sharing and learning session on how farmers' rights through Community Based Seed Systems (CBSS) can be promoted in the region. At the end of the three-day workshop, the participants outlined some key elements for a CBSS endeavor that promotes farmers' rights and at the same time provide seeds to small scale family farmers at the right time, with the right quality and quantity, and with affordable price. This article presents the highlights of this three-day learning workshop, the key lessons learned in promoting CBSS and key action points that representatives from government and Farmers' Organizations (FOs) can take to further promote CBSS in their countries and in the region.

Keywords: Smallholder, formal seed system, integrated approaches, informal seed system

1. Overview of the Workshop

The SAARC Agriculture Center (SAC), the Rural Development Academy (RDA), the Asian Farmers' Association for Sustainable Rural Development (AFA) and the Action Aid Bangladesh (AAI) co-organized a ***Learning Exchange on Community Engagement on Seed Sovereignty for Resilient Agriculture*** in South Asia, held May 19-21, 2018 at the RDA Compound in

Bogura, Bangladesh. It brought together 38 representatives from all member states of SAARC, and from farmers' organizations and non-government organizations in five countries. SAC was happy to note that the workshop was able to bring representatives from all SAARC Member States. And for the first time also, it brought together representatives from member states and representatives of farmers' organizations in a learning and sharing workshop about CBSS.

The workshop had three objectives:

i) To describe the experience and the challenges each country and each FO faced in promoting sustainable seed management and seed sovereignty.

ii) To capture the lessons learned from these experiences and initiatives through—identifying the technologies on sustainable seed management being practiced—identifying key factors of success, key tips and guidelines in promoting the technologies for sustainable seed management and seed sovereignty.

iii) To identify action points that participants can do to improve a particular aspect or facet in promoting seed sovereignty at country and at regional-South Asia-levels.

The first day of the workshop was held in Dhaka, Bangladesh, with two sessions. The first session served as the inauguration of the workshop, with the presence of chief guest Mr. Ashraf Uddin Ahmed, Additional Secretary and Director General, Seed, MoA Bangladesh, who gave the inspiration message. The opening program was chaired by Dr. Md. Kabir Ikramul Haque, Executive Chairman, Bangladesh Agricultural Research Council (BARC). The second session discussed the contextual framework, with four presentations on: i) Seed System in South Asia by Dr Pradyumna Pandey, Senior Program Specialist (Crops) of SAC; ii) The salient provisions of the International Treaty of Plant Genetic Resources for Agriculture (ITPGFRA) by Juanita Chavez Posada of the Global Forum on Agricultural Research (GFAR); iii) Seed Sector in Bangladesh by Md. Shajahan Ali, a seed technologist and regulation specialist from the private sector; and iv) The work of the regional NGO called Local Initiatives for Biodiversity, Research and Development (LI-BIRD) as presented by Dr. Keshab Khadka from All Nepal Peasant Federation Nepal (ANPFa).

The participants then travelled to the Rural Development Academy complex located in Bogura, Bangladesh, to continue with the sessions on the second and third day.

The morning of the second day was devoted to a sharing of experiences on community- based seed systems, by representatives of all eight SAARC member states as well as of Farmers Organizations from Self Employed Women's Association (SEWA) in India and Lanka Farmers Forum (LFF) in Sri Lanka and Kendrio Krishok Moitree (KKM) in Bangladesh. The sharing session was followed by a group work where participants identified successful factors and lessons learned from the presentations given. In the afternoon, the participants visited a village where women farmers practicing the Maria Model eagerly showed their initiative. The third day was spent on identifying some ways forward and key action points, in efforts to apply lessons learned from this workshop.

The following sections highlight the key discussions and learning points from the three-day workshop that was just described above.

2. Rationale of the Workshop

Seeds are the heart of agriculture and the source of foodstuff, and are deeply associated with the whole food system including diversity, reliance and food security. Seed security is profoundly linked with the livelihood of farmers. Seeds are saved by farmers and exchanged among themselves and improved in accordance to local environmental conditions from time immemorial. The conventional knowledge, traditions and customs are also passed along with the process of seed exchange among farmers. With rapid change of agriculture, traditional seed systems which were controlled by farmers have eventually moved to government sector plant breeders and further to private seed companies. Today, the majority of the seed market is controlled by a few giant multinational seed conglomerates. These big seed corporations continue to acquire many small-scale seed companies in order to maintain the monopoly of seed business, and generate the most profits.

With the introduction of improved seed varieties and more importantly hybrid seeds and GMOs, the companies successfully convinced farmers to keep on purchasing these commercial seeds year after year. This adversely affected the traditional seed saving, replanting and sharing process. The traditional knowledge on seed saving was also lost as farmers are refrained from such activities. As a consequence, the vulnerability of the farmers have been increasing rapidly, thus making the farmers more marginalized. Further, the traditional knowledge of the farmers associated with seed is also jeopardized.

The seed research and seed production are confined only towards most profitable proprietary crops and varieties which in turn adversely affect seed diversity. Since 1990s, about 75% of agricultural crop genetic diversity has been lost as farmers have left multiple local varieties for genetically uniform high yielding varieties. Further, 90% of traditional crop varieties have also disappeared from farmer fields.

The change of seed systems towards more control of a fewer multinational companies and less control of the farmers has affected the genetic diversity as well as the farmers' rights. Farmers have little scope to participate in the seed policy regime even if South Asia is a region with high plant diversity. There is an increase in seeds imported by South Asian countries, especially hybrid seeds and GMOs which threaten the seed diversity and the seed sovereignty.

Seed sovereignty is a natural driver of local seed development and the development and maintenance of seed diversity. There are existing initiatives of farmers' groups and organizations in meeting farmers' demands for quality, affordable, accessible and resilient seeds through community seed banks, seed producer cooperatives and partnerships with seed companies. There are also research institutions, particularly the NARS who partner with farmers organizations in the production and distribution of quality seeds. Some governments have policies that help promoting seed sovereignty and access to quality and affordable seeds and the self-determination of a farmer to save, select and share seeds.

The aim of the workshop was to share and learn from the experiences of various farmers' organizations and government institutions in promoting policies and programs for achieving seed sovereignty for resilient agriculture.

3. Key Challenges in the Seed Situation in South Asia

South Asia is home to about 1.7 billion people, 75% of which live in the rural areas. It is to be the fastest growing region in the world. Agriculture remains an important sector as it provides employment to 48% of its population, though its share in total GDP has been decreasing and incomes from agriculture is low.

In South Asia, as in the world, there are two seed systems: the formal and informal. The formal seed system, done with government and private sector, supplies 20-30% of seed requirement, while the informal system supplies 70% -80%. Thus the informal seed system, mainly through community based

seed system (CBSS), has a pivotal role in meeting the seed requirements in the region.

This CBSS, commonly known as community seed banks, or seed villages, or seed cooperatives, is defined as "an informal arrangement wherein a farming community or a group of farmers has established a scheme or collective system of producing and exchanging or selling good-quality seeds, especially in times of disasters or seed shortages. This arrangement can vary, from simple exchanges on agreed terms and conditions to a more systematic selling or trading of seeds within a locality or an extended geographic reach. As differentiated from a formal seed system, good quality of seeds is ensured under a community-established guarantee system that approximates seed certification under a formal system. In different countries, good-quality seeds are often labelled or referred to as "truthfully-labelled seeds," "extension seeds," "farmers' quality seeds," or "quality seeds," as differentiated from formal or commercial "certified seeds". However, the informal seed system, especially the community-based seed systems, are hardly recognized and supported by governments in South Asia. Many family farmers experience problems in getting the right quality and right quantity of seeds of their choice at the right time and with affordable price.

Seed systems are governed by policy instruments at national level, such as seed laws, policies, regulations and certification. At the regional level, the SAARC member states have approved a SAARC Seed Bank established in 2016, as well as a SAARC Seed Forum established in 2010.

4. Farmers' Right Under the ITPGRFA

The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), is a legally binding instrument which came into force in 2004. Its objectives are the conservation and sustainable use of all plant genetic resources for food and agriculture and the fair and equitable sharing of the benefits arising out of their use, in harmony with the Convention on Biological Diversity, for sustainable agriculture and food security. According to this treaty, Farmers' Rights includes:

- Receive benefits from the use of their seeds.
- Protect and promote their traditional knowledge, innovations and practices.
- Participate in decision making on matters related to the conservation and use of plant genetic resources.

- Save, use, exchange and sell farm-saved seeds or propagating material.
- Farmers' efforts to manage and conserve on-farm plant genetic resources should be promoted and supported.
- Adoption of national policies for promoting the development and maintenance of traditional seed systems, enhancing the sustainable use of agricultural biodiversity and other natural resources.
- Promote participatory plant breeding and strengthening the capacity of farmers to develop seeds adapted to ecological conditions.
- Promote the expanded use of local and locally adapted crops, varieties and underutilized species.
- Promote seed exchange and commercialization through seed fairs.
- Promote the conservation of seeds on-farm through community seed banks.
- Adjust legal regulations concerning variety release and seed distribution allowing quality certified seeds from traditional seed systems to be commercialized.
- Promote the conservation of local crops and traditional knowledge through in-situ catalogues.

5. Various Practices on CBSS Shared during the Workshop

i) ***The Maria Model for Seed Preservation—***The workshop host, the Rural Development Academy (RDA), initiated several research programs to explore how women could become key players in the transformation of Bangladesh's seed industry. Among the Academy's successful initiatives in rural seed technology development is the Maria Seed Technology Model.

This seed technology model got its name from the village of "**Maria**", a densely populated area situated on the bank of river Karotoa in Amrul Union of Shahjahanpur upazila of Bogura, where the residents are dependent in agriculture for their livelihood. In 1999, RDA implemented the "Seed Health Improvement Project" in the village where the farmers were taught about seed preservation. RDA noticed that the women mostly do the seed preservation/ management. Around 200 women in the village are involved in the seed business. Noticing this, RDA involved the women in the project, which was a success. Seeing what they have done, around 600 more women in the same village were inspired and did the same thing. These women lifted up the standard of their living, and contributed to the national income. The

Maria Model was replicated and validated in different locations. It is nationally and internationally acclaimed and is said to be used in West Africa, Nepal, India, and Cambodia.

To further take Maria Model forward, RDA conducted an action research program with rural women seed growers, and this resulted to the "**Women in Seed Entrepreneurship (WISE) Model**", where local NGOs, seed companies, and dealers are involved as partners. The partner institution forms women seed micro-entrepreneur groups. The partners provide training to these groups to enable them to produce and sell quality seeds. By upgrading women's group to WISE association, the women farmers will have a stronger voice and capacity to negotiate and therefore, be able to operate seed business beyond their community markets and even persuade them to start a seed business. A lot of rural women have also benefitted from this progressive policy. The results of these initiatives demonstrated great potential for women to be at the forefront of the activities within seed production, processing, preservation, and business. Women have demonstrated effective knowledge adoption, improved production practices, and secured higher income after getting involved in seed business.[1]

ii) ***Homna Model***—Homna is an Upazilla of Cumilla district in Bangladesh. A Community Farmers Club Seed Store operates since 2013 as a seed dealer in the Upazilla. Its main activities include seed production, storing, and purity testing and packaging of quality boro rice seed. The seed store source their seeds from the government's seed center.

iii) ***CBSS in Bhutan***—The National Seed Center in Bhutan supplies 100% of hybrid vegetable seeds and 80-90% fruit tree seedlings. These seeds are then supplied directly to farmers through the district and block agricultural offices as well as through sales outlets. Truthfully-labelled and certified seeds for cereals, oilseeds and legumes are produced by individual farmers or CBSS groups and are distributed mainly by these farmers or groups, sometimes selling small quantities at the local vegetable markets. Seeds produced under this informal system is controlled by BAFRA.

iv) ***Self Sufficient Sustainable Seed System for Rice (4S4R) Model* in India**—At the center of the model are farmers' organizations at block level, which are formed as Seed Producer Groups, Seed Processing Enterprise and

[1] From Maria Seed Technology Model to Wise Model: http://asianfarmers.org/maria-seed-technology-model-wise-model-bangladesh/

Seed Sale and Marketing Enterprise. The groups provide an internal quality monitoring system. The seed centers at national, state, district levels provide support to these Farmers Producers organizations through supply of breeder seeds, credit support, awareness raising and capacity building and certification and marketing of produced seeds. A mobile application on Paddy Seed Expert System was also developed, aimed to help farmers resolve their problems related to food production.

v) ***Agricultural Campaign of Self Employed Womens' Association (SEWA)***—SEWA is a member-based trade union with 1.4 million members, all women, spread across 7 states in India. Seventy five percent (75%) of members are small scale farmers. Its agricultural campaign aims to make agriculture viable, providing livelihood, incomes to farmers while promoting ecological stability. SEWA has realized that out of all the agricultural inputs, seed is the most basic and most critical input for sustainable agriculture. Its agriculture campaign included a well-developed and knitted seed multiplication and distribution system linked with several government agriculture institutions. SEWA has encouraged its members to establish seed banks, with farmer members preserving seeds from their harvests for subsequent use for next planting cycle. It has established 493 seed plots where farmers can store their seeds for wheat, cumin, chickpea, sesame and groundnuts. The seeds produced by the farmers are procured by the seed bank, for further distribution to the farmers of nearby villages and districts. To decentralize the process of the seed distribution system and to involve the local community it encouraged the seed bank groups to get Seed Licenses; currently two of their groups have been given such licenses. SEWA linked these two groups with their local banks to be able to access financial credit and to purchase the seeds on time.

vi) ***Community Based Seed Production Approach, Sri Lanka***—the government of Sri Lanka works with self-organized Seed Producer Societies, with each society having 25-30 members. They receive registered seeds from the Department of Agriculture (DOA), which they multiply in their seed plots as DOA labelled seeds. Seeds from these societies' plots are then given or sold to the local farmers.

6. What Will Make a Good CBSS

After the sharing session on successful CBSS initiatives, the participants held small group discussions to identify some key elements on "What will make

a good CBSS". In general, the participants said that it is important that governments recognize the potential of CBSS to promote an effective seed system that provides to farmers seeds at the right time, right quality, quantity and affordable prices. This informal system can best be implemented by farmers' seed banks, groups and cooperatives at local levels. These local groups should be affiliated at the national level so as to influence decision making processes from bottom up, and from top to bottom. Also, these seed groups need to have an entrepreneur approach so as to generate resources to further strengthen their work and provide income to some members. As seed production and multiplication is mainly the work of women, the participants also stated that women farmers must be involved in all the process of seed production, multiplication, distribution and preservation as well as in the decision-making processes of the farmers' seed groups and organizations.

More detailed discussion on this topic were as follows:

i) Production and Preservation

- Foundation seeds are made available to selected/recognized farmers/ farmers' groups for seed multiplication.
- Recognition of indigenous knowledge, including farmers' breeder seeds.
- Production and preservation of seeds for crops and breeds for livestock in an integrated manner.

ii) Marketing and Distribution

- Ready markets are available, such as through public procurement of seeds multiplied by the farmers / farmers/ groups.
- Minimum price support for seeds are established.
- Strong capacities of seed groups and cooperatives for entrepreneurship are strengthened.

iii) Support System

- Available loans with low interest for seed production and marketing.
- Good documentation and standardization are established
- strong capacity of farmers and their groups for the conduct of participatory action researches in the field.
- Strong partnership with the formal seed system, especially with the government, clearly defining roles and responsibilities, and the support that will be given.

iv) Organization Expression

- Local farmers are organized not only at local levels but also at national levels to be able to influence and engage in the decision -making processes on national seed laws and policies
- farmers groups at local and national level have strong skills and attitudes on seed entrepreneurship and a clear orientation on seed sovereignty and farmers' rights.
- Recognition of national family farming organizations as legitimate organizations that can engage with governments and partner with them on the various programs for seed sovereignty.

7. Recommendations for Moving Forward

The participants agreed to harness the potentials of the informal seed system, through the community-based seed groups, banks, villages, cooperatives and societies, in close partnership with the government. They committed to further strengthen their existing CBSS, to incorporate key elements of a good CBSS that was earlier identified. They expressed interest to have further exposure to successful CBSS models in other member countries.

At the regional level, the participants agreed to work together to realize a **network of CBSS champions and practitioners at South Asia** level. This network can be the **SAARC flagship program on CBSS**, with SAARC providing financial support for South-south cooperation that involves capacity building, exchange visits as well as implementation of the following endeavors at the regional level:

- Piloting/scaling up CBSS through the replication of good technologies, some of which have been presented during this workshop.
- Establishment of a gene bank.
- Harmonization of seed policies and acts, rules and regulations and plan quarantine under the guidelines of IPCC.
- Promoting the authentication, validation, accreditation, recognition of CBSS in a farmer-friendly manner.
- Documentation and validation of indigenous technologies on seed breeding, multiplication, preservation, distribution and marketing.
- Creation of a website to provide online information and exchange on the work of the flagship program on CBSS.

To move these recommendations forward, the participants agreed to identify "CBSS champions" from each country to develop the proposed flagship program on CBSS, which can then be submitted to SAARC for further deliberation and approval, if possible. An initial core group composed of RDA, and representatives from SAC, AFA, Action Aid International and other key CSOs can be formed to initiate the planning processes for this flagship program.

Chapter 5

Strengthening Seed Systems for Improving Food and Nutrition Security in Afghanistan

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Abstract

Efficient seed system, particularly the Community Based Seed System (CBSS) is considered as an important strategy to increase farmers' access to diversified crop varieties in rural areas. Formalizing the CBSS and its sustainability to deliver quality seeds to the smallholder farmers are the major challenges. This paper has been prepared using the secondary information and literature review aiming to analyze the seed system focusing the CBSS and prescribe recommendations for efficient functioning CBSS in Afghanistan. Some major intervention on efficient seed systems are: i) Capacity building in seed production, pest and diseases management, seed cleaning, grading and trade facilitation; ii) Develop varietal development technology aligning to the CBSS; iii) Formalize CBSS and farmers' exchange of seeds maintaining certain procedures and standardizations; iv) Increase investment from public and private sectors; v) Virtual collaboration between government, private sector, international development partners, seed companies. Efficient seed systems could increase the production of crops that contribute to improve the food and nutritional security in the country.

Keywords: Formal and informal seed, capacity building, financial support

1. Background

Afghanistan is between 29°40′ and 38°40′ N and 60°31′ and 75°00′ E. It bordered by Iran in the west; Pakistan in the south and east; Turkmenistan, Uzbekistan and Tajikistan in the north; and China to the east. Afghanistan is generally considered as Central Asia, but it is also grouped either in the Middle East or in South Asia. It has total area of about 65 million ha. The

population of Afghanistan was estimated at 34 million in 2010 with a growth rate of 2.4%. Afghanistan is a mountainous country with the Hindu Kush system stretching about 966 kilometers and splitting the country from east to west. There are several smaller mountain ranges; the lowest point of elevation is Amu Darya 258 meters and the highest one is Nowshak 7,485 meters. These mountainous areas are mostly barren or at most sparsely sprinkled with trees and stunted shrubs. In addition, the country has many rivers, lakes, and deserts. The four major river systems are: Amu Darya, Helmand, Harirud, and Kabul.

Afghanistan is divided into six agro-ecological zones: i) Northern Zone (Balkh, Samangan, Jowzjan, SariPul and Faryab provinces); ii) North-Eastern Zone (Baghlan, Kunduz, Takhar and Badakhshan provinces) known as food baskets (except Badakhshan); iii) North-Western Zone (Badghis, Herat, Ghor and Farah Provinces) mostly rangeland and rainfed areas; iv) Western Zone (Nangarhar, Laghman, provinces) known for production of vegetables and (Kunar and Paktika provinces) for agroforestry; v) East Central Zone (Bamyan, Parwan, Kabul, Panjshir, Dikundi, Logar, Wardak, Kapisa and Ghazni provinces) high elevation with cold winter; and vi) Southern Zones (Nimroz, Helmand, Kandahar, Oruzgan and Zabul provinces) low elevation with arid and semi-arid climate. Afghanistan has mostly a sub-arctic mountain climate with dry and cold winters, except for the lowlands, which have arid and semi-arid climates. It has clearly defined seasons where summers are hot and winters can be bitterly cold. Variations in temperature during the day may range from freezing conditions at dawn to the upper 30°C at noon. Summer temperatures are as high as 54°C (in Zranj) and the lowest temperature recorded is -54°C (Shark). Most of the precipitation falls between the months of October and April. The desert receives less than 100 mm of rain a year, whereas the mountains receive more than 1000 mm of precipitation, mostly as snow.

Afghanistan's economy is recovering from decades of conflict. Since 2001, the economy has improved significantly because of inflow of international assistance and gradual recovered the agricultural and the service sectors. Agriculture is the mainstay of the Afghan economy accounting for about 32% of the GDP and supports over 80% of the population for their livelihoods. About 12% of the country's total land area is arable mainly in scattered valleys, 46% is under permanent pastures, and remaining 39% being mountainous. Desertification, particularly in the southwest, and deforestation are increasing at an alarming rate, while some of the pastures

are cultivated when rainfall is plenty and left fallow the following year, causing some erosion and loss of grazing land. Water is drawn from springs and rivers and is distributed through surface ditches and through underground channels/ tunnels, which are known as *karez (qanat)*. In 1987, about 2,660,000 ha of farmland were irrigated. The most of the rural population depend on agriculture, while a significant proportion of the population do not own farmland. About 80% of farming households own the land less than 2 ha, while nearly 50% households own lands less than 1 ha in the country.

Wheat is the main staple cereal crop accounts for about 70% cropped area, which cover 70% of total cereal consumption. Wheat cultivation was estimated to cover 2,575,000 ha (1,426,000 ha rain-fed and 1,149,000 ha irrigated) during 2008/09 crop season, which recorded one of the highest production levels (5.06 million tonnes). The average yield of wheat was estimated to be 2.5 tonnes/ha; while it is 2-3 times higher in irrigated than that of rain-fed wheat. The major challenge in the country is to enhance the productivity and narrow down the yield gap of wheat crop. Cereals (barley, rice, maize) and pluses (chickpea and mung bean) are also important crops. Several summer and winter vegetables like potato, tomato, onion, okra, cauliflower, melon and watermelon are also produced both for domestic use and export markets. Cotton is also a widely cultivated crop. Fruits (apricots, cherries, figs, mulberries, pomegranates and grapes) and nuts (pistachios, walnuts) are among the most important export crops produced.

There is a considerable deficit in food production and consequent effects on food insecurity, particularly in the resource poor vulnerable group of people. Increasing yields and reduce the yield gap in wheat production could improve the food security in the country. Furthermore, the focus on crop diversification especially into food legumes and vegetables will help to improve the current poor nutritional status of rural farming households. Studies showed that the yield could be increased by 25% through using the improved seeds alone. Therefore, this paper analyzed the situation of seeds and production of major crops, constraints/ challenges and opportunities for making improved seeds accessible, CBSS, and way forward to improve CBSS in Afghanistan.

2. Crop Production in Afghanistan

Wheat is the major staple food crop produced 4.3 million tonnes, which was decreased by 2.5% compared to the previous year (2015/16). Rice production

was 0.34 million tonnes, which was decreased by 13.03% than the previous year due to reduced area coverage of cultivation. Barley production was 0.94 Million tonnes and maize production 0.17 million tonnes (Table 1).

Table 1. Area of cultivation, production and yield (2017/18)

Indicator	Area (ha)	Production (tonnes)	Yield (tonnes/ha)
Wheat	2,104,377	4,280,776	2.03
Rice	109,452	338,420	3.09
Barley	68,179	94,995	1.39
Maize	134,225	173,912	1.29
Potato	32,116	513,194	15.98
Sugar Beet	201	2,102	10.46
Sugar cane	1,145	33,725	29.45
Almond	19,793	27,291	1.379
Walnut	4,580	6,515	1.560

Source: MAIL (2018)

The common vegetables are potato, pepper, onion, tomato, eggplant, carrot, turnip, radish, cauliflower, okra, lettuce, cucumber, squash, spinach, green bean, cabbage. Vegetables are grown for both home consumption and selling purpose. Vegetable crops cover 5.9% of the total irrigated area. Potato was produced 427.9 thousand tonnes in 35.7 thousand hectares of land having yield 11.9 tonnes/ha in 2018. The major fruit tree varieties are apple, pomegranates, apricots, mulberries, grapes and almonds.

3. Seed Industry in Afghanistan

3.1 Establishing Organized Seed Industry (1978–1992)

Until late 1970 there was virtually not any large scale organized seed delivery in Afghanistan. The first government established Afghan Seed Company (ASC) in 1978 with a loan of US$ 14 million from the Asian Development Bank. The main aim of the ASC was to perform seeds delivery including seed production, processing, distribution and marketing. ASC was changed into the Improved Seed Enterprise (ISE) in 1985 with its headquarters located in Kabul and sub-offices in different provincial towns (namely, Herat, Kandahar, Kunduz, Mazar, Nangarhar and Pulikhumri). ISE was allocated

21 farms across the country with a total area of over 11,700 ha, about half of which were developed for seed production.

From 1982 to 1992, the ISE under the Ministry of Agriculture, the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Development Program (UNDP) operated several joint seed projects in Afghanistan (FAO, 2014). The UNDP/FAO assisted vegetable seed production and training project established five seed production and training farms, vegetable seed processing facilities, seed testing laboratories and a seed technology training center. This project was followed by a seed improvement program for northern Afghanistan, which focused on production of cereal seeds, vegetable seedlings, and fruit tree saplings for distribution to farmers. Almost all these facilities were destroyed and looted during the conflict in 1992. In 1993, due to security situation, FAO shifted its operational base from Kabul to Islamabad, Pakistan.

3.2 Sustaining the Seed Industry (1993–2002)

After 1992, FAO implemented two seed projects from its base in Pakistan through NGOs and local communities cross border for seed multiplication of vegetables, wheat and maize. Furthermore, during 1995-2002, FAO collaborated with World Food Program (WFP) to implement a "Food for Seed Scheme", which subsidized seed production and gave the implementing partners an opportunity to accumulate substantial revolving funds from seed sales. In addition, during 1997-2002, FAO received significant supports from the UNDP Poverty Eradication and Community Empowerment (PEACE) program, which included trust fund projects that were designed to support household food security by strengthening community seed production (Vilas et al., 2012). The PEACE initiative was aimed at the restoration of peace in Afghanistan through poverty alleviation, good governance and community empowerment in both rural and urban areas, of which seed was a major component. This program helped in laying the foundation for rebuilding the Afghanistan seed industry. Following the collapse of the Taliban regime, FAO returned its operational base to Kabul in 2002 and the PEACE program ended.

3.3 Rebuilding the Seed Industry (2002)

The Future Harvest Consortium to Rebuild Agriculture in Afghanistan (FHCRAA) led by ICARDA and supported by USAID, the French Cooperation and many national and/or international NGOs have initiated

interventions for promoting seeds since 2000. About 15,000 tonnes of wheat seed, mostly imported from Pakistan and distributed to farmers. In addition, the FHCRAA/ ICARDA renovated and equipped agricultural research stations and seed testing laboratories and initiated village based seed enterprises. The French Cooperation introduced several wheat varieties for testing at research stations and seed of promising ones are being multiplied by farmers. FAO has continued its role as seed industry leader in terms of variety improvement, seed production, seed enterprise development and regulatory reform. The EU supported projects 'Strengthening National Seed Production Capacity' (2003-2006) and Variety Development and Seed Industry Regulation' (2007-2011) have played a key role in re-establishing the seed sector in Afghanistan.

3.4 Seed and Planting Material Certification

Seed and Planting Materials Certification Directorate (SPCD) was formally established headquarter in Kabul and its agencies in Bamyan, Nangarhar, Helmand, Herat, Kundoz and Mazar-e-Sharef under the framework of Ministry of Agriculture, Irrigation and Livestock in 2014. SPCD is responsible for the certification of seeds and planting materials, field inspection, sampling, seed testing, seed health testing, distribution of tag and certificate implementing pre-control plot, post control plot and other tasks.

4. Existing Programs for Promoting Seed System

4.1 Seed System for Wheat

The main seed promotion programs includes on-farm demonstrations and farmers' field days organized by private seed enterprises. These program activities are effective by combined efforts of concerned stakeholders such as Ministry of Agriculture, Irrigation and Livestock (MAIL), local administrative officials, NGOs, enterprises and contract growers, university/ vocational staffs, students and farmers. Apart from the MAIL extension service, there are other extension efforts ongoing in the country provided through the private seed enterprises, NGOs and other development agencies. A key to effective awareness creation about the availability of new varieties and certified seeds should require synergy from close collaboration and coordination of the various extension undertakings in the country.

Since the establishment of private seed enterprises, three national seed fairs have been organized to exhibit the diversity of seeds and planting materials

available in farming communities as well as to bring together stakeholders including policy makers, technical officials, business groups, farmers, etc. Such events helps to exchange views and ideas pertaining to variety choice, seed multiplication, exchange and marketing. The fairs attract a wide range of stakeholders including seed enterprises, farmers, NGOs, seed and agro-chemical dealers, research institutes, donors, senior MAIL officials and many other stakeholders nationwide.

4.2 Research on Vegetable Crops

Prior to the conflict, agricultural research was coordinated by the Ministry of Agriculture through 17 Research Stations representing different agro-ecological regions of the country. In the absence of functioning research system during the conflict period, FAO provided technical assistance in variety development including a crop improvement project funded by the Swedish International Development Agency during 1996–1999, which resulted into the release of several new crop varieties. Following the rehabilitation of some agricultural research stations by ICARDA in 2002, some research activities were initiated in major agricultural Research Stations, while FAO continued to support variety development activities. The Agricultural Research Institute of Afghanistan (ARIA) was formally established in the early 1980s with its headquarters in Kabul and regional agricultural research stations in Baghlan, Bamiyan, Helmand, Herat, Jalalabad, Kandahar, Kunduz, Mazar and Takhar.

5. Seed Policies and Strategic Priority Areas

The Ministry of Agriculture, Irrigation and Livestock (MAIL) adopted a *National Seed Policy 2005*, which is in place of implementation under the guidance of the National Seed Board. The policy is intended to provide an enabling environment for sustaining and enhancing the growth of the Afghanistan seed industry by defining appropriate strategies relating to seed legislation, agricultural research and variety development, seed production, processing and storage, seed marketing and distribution, quality control and certification, plant quarantine, private sector participation, human resource development, informal seed sector, seed security, emergency seed interventions, credit and financial assistance, oversight arrangements and international cooperation.

National Comprehensive Agriculture Priority Program (2016-2021) was formulated in 2016, as the major guiding strategy to the overall security,

good governance and economic development agenda of the Government of Islamic Republic of Afghanistan. Built around the core national objectives of self-reliance and increased income and employment generation, the strategic framework set forth seven key priorities. These **Strategic Priorities are**: i) Improving Irrigation Systems; ii) Wheat and Cereal Production; iii) Development of Industrial and High Value Horticulture Crops and Vegetables; iv) Livestock Development; v) Climate-Change Sensitive Natural Resource Management; vi) Food and Nutrition Security and Resilience Building; and vii) Institutional Reform. The following are the priority programs.

i) Wheat and Cereal Production

Sustainable development of the wheat sector in order to achieve self-sufficiency, improve food security and better response in cases of emergency and crises across the country are the objectives of the National Wheat Program. This will involve improving productivity, and will require taking a more pro-active approach in partnering with the private sector, and facilitating farmers to achieve economies of scale through well-tailored agricultural packages. Both of these tasks face numerous challenges in acquiring high quality agricultural inputs, incentivizing private sector investment to strengthen market elements of the value chain and ensuring aging seed is constantly replenished by new high-yield location- specific varieties. Within the next five years, the MAIL address a number of systemic and technical challenges in a more coherent manner in order to meet the production target of 5.9 million tonnes. The MAIL anticipates an expansion of additional 110 thousand hectares of irrigated and rain-fed wheat cultivation, increase current yield for irrigated land from 2.45 to 3.1 tonnes/ha and rain-fed land from 1.03 to 1.3 tonnes/ha. Strategies for dry-land farming will also be expanded in order to effectively utilize the land where irrigation shortages continue to occur. Other cereal crops such as rice, to be increased to 1 million tonnes in five years, while production of maize and barley will be intensified for feed and crop rotation purposes.

ii) Horticulture Crops

Horticultural crops cover approximately 360,000 ha, accounting for 14% of the total irrigated land area and employing more than 2 million people along the value chain. Among the perennial horticultural crops, the strategic importance crops are grapes, pomegranates, almonds, pistachios and vegetables. The horticulture subsector contributes US$1.4 billion (6.7%) to

the national GDP, equivalent to 34% of agricultural GDP. This sub-sector has grown at the rate of 5.5% per year over the past decade, and has the potential of expanding further, raising farm incomes, generating productive jobs and improving food security in the rural and urban communities if timely investment is made in agro-processing. **Some critical priorities for the intervention in horticulture are:** i) Expansion of horticulture land-base by at least 12,400 ha/year; ii) Increase productivity; iii) Develop promising value-chains; iv) Infrastructure and market development; v) Standardization; vi) Support private sector; vii) Develop nursery industry; and viii) Expand the land under protected agriculture.

iii) Food and Nutrition Security

Afghanistan is a country with high-levels of food insecurity (33%) and frequently encountering severe malnutrition. A greater efforts to be given in improving the utilization of nutritious foods through dietary diversity (e.g. kitchen gardening, commercial and school gardening) and food safety. Building upon evidence-based strategies from previous similar endeavors, MAIL will collaborate closely with other Afghanistan Food Security and Nutrition Agenda (AFSANA) members to have synergetic efforts in a systematic and sustainable manner. It should also bring the gender gaps more closer by providing environment to engage women in agriculture providing technical and financial supports, promoting nutrition and gender sensitive agriculture, launching urban and peri-urban agriculture, small-scale agro-based enterprises, enhancing women's skill development training programs at community level and women micro-entrepreneurship in view of women's restricted mobility.

iv) Research and Extension

Seventeen Research Centers spread over in the seven agro-ecological zones have been established and are key to enhance extension works across the country. In addition, Perennial Horticulture Development Centers (PHDCs) are established in six locations in all major agro-ecological zones of Afghanistan, and provide a repository of the national collection, conduct adaptive research on fruit trees, provide training and demonstration facilities for farmers, and provide improved saplings and root stock for the nursery industry. The merging of both extension and research holds great promise in terms of driving improvement both in plant and animal research to ensure that the quality of native breeds and species enjoy are preserved and protected. Improvement of new strains of animals and plants are vital to a

strong horticulture, cereal and animal production industry. Building Farmer Resource Centers (FRCs), provide a unique opportunity to refocus provincial office activities on technical matters including becoming important source of information support to district level Integrated Agricultural Service Centers. This will be additionally supported by training agriculture faculty graduates and extension officers at the National Agriculture Extension Institute recently established at MAIL in Kabul.

v) Farmer's Union and Selection of Seed Producers

Once crops for multiplication have been identified through farmer's participatory selection, then communities can select individuals from their seed growers. Since food crops are known to be conserved and multiplied mostly by women, it is only appropriate and advantageous that seed production of such crops be done by them. To help farmers, carefully select their local seed growers, the NGOs can help facilitate a process developing criteria for selecting seed growers. **Some suggested criteria for selecting seed growers are:** i) Should be resident of the village; ii) Should be a farmer with land holding; iii) Trustworthy; iv) Willing to attend training programs; v) Friendly in nature and approachable by others; vi) Inclination to put sincere efforts; vii) Willing to work in a team; viii) Experienced in growing one or more crops intended for multiplication; and ix) Honest and willing to repay seed loans.

6. Constraints and Challenges in Seed Systems

6.1 Constraints in Formal Seed Systems

Formal seed system covers very limited proportion in Afghanistan. The government distribute 15,000 thousand tonnes of wheat seed per year with 20% replacement rate. So the majority of the farmers used their own seeds from farmer to farmer exchange. As informal seed system is more important in developing countries (Joseph, 2012), more than 70% farmers depend on informal seed system in Afghanistan. In case of vegetables and pulses, there is not any support to improve seed system. The following are some constraints in seed system in Afghanistan**.**

- The varieties developed in the national research system are often not adopted by small farmers due to weather stresses and lack of inputs.
- Seeds are not available on planting time with affordable price to the farmers.

- Lack of technical human resources to increase the seed breeding system.
- The development and release of varieties from the formal system is very limited thus the farmers do not have better alternatives for the best varietal selection.
- The formal seed prices is not affordable to the resource-poor farmers.
- Poor incentives and logistic supports in seed varietal development, technology development and diffusion system.

6.2 Constraints on Informal Seed Systems

Most smallholder farmers (75–90%) depend on informal seed source, use their own saved seeds or exchange among farmers for cultivation of crops and most of them use grain as seeds that reduced the level of productivity. Some of the major challenges encountered by farmers on the informal seed system are:

- The seed quality is often deteriorated due to biotic stresses and storage problems.
- Seed exchange is limited to a diverse geographical areas and governed by cultural barriers.
- Crop failures or low yields have a tremendous effect on the availability of seeds to the smallholder farmers.
- CBSS is a part of informal seed system. The government neither recognize nor provide the policy and program support this support.

7. Recommendations

Technology development in the seed varietal improvement characterized by high yielding and stress tolerance is the first condition in the seed system. However, more than 70% of the seeds are used from informal sources, such seeds are not streamlining into the registration and releasing process. Realizing the importance of informal seed system therefore following recommendations are derived.

i) Access to improved seed to the smallholder farmers in planting time with standardized quality and affordable price to the farmers.

ii) Increase responsible investment from public and private sectors, encourage multi-national companies to virtual collaboration with CBSS and farmers' seeds.

iii) Capacity building of the farmers, seed producers, technicians, private sector companies, traders, government staffs and concerned stakeholders on production, value addition and trading of improved seeds.

iv) Financial supports to the smallholder farmers in the rural areas and provide loans with subsidized interest rate to the seed producers, processors and traders.

v) The seeds produced by CBSS need to be formalized with certain regulations and procedures along with maintaining minimum quality standards.

vi) The government should formulate policies and programs to foster and streamlining the informal and CBSS seed system to easy access of quality seeds to the resource poor farmers.

8. Conclusions

Availability of quality seeds during planting time with affordable price to the smallholder farmers is the major challenges in the developing and least developed countries including Afghanistan. Informal seed system is the major sources (more than 70%) of seeds used by farmers, while it is constrained by quality, technology, reliability, and recognition and policy incentives from the government. Because of the lower quality standard of such informal seeds, farmers lost the crop productivity, reduced income and multiplier effects on poverty and food security. We recommend interventions to strengthen seed systems: i) Develop varietal development technology aligning to the CBSS; ii) capacity development of farmers, seed producers and processors; iii) Formalize CBSS and farmers' exchange of seeds maintaining certain procedures and standardizations; iv) Increase investment from public and private sectors; v) Virtual collaboration between government, private sector, international development partners, seed companies. Availability of quality seeds on planting time to the farmers would help to increase crop productivity, enhance income, and eventually contribute to the food security and poverty reduction.

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Country Perspective Paper

Chapter 6

Strengthening Seed Systems for Improving Food and Nutrition Security in Bangladesh

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Abstract

The Seed System in Bangladesh is comprised of three categories: Formal Seed System (FSS); Semi-Formal Seed System (SFSS); and Informal Seed System (ISS). The quality seeds of improved varieties are produced and distributed to farmers mainly by public and private sectors. In the SFSS, the Foundation Seed (FS) supplies by Department of Agricultural Extension (DAE) to the contract farmers, thereby the contracted farmers produce Truthfully Labelled Seed (TLS) and they use TLS for their own crop production and they also distribute/ exchange it with their neighbor farmers. The ISS is mainly the produce and use of seeds by farmers of their own traditional varieties without maintaining seed quality standards. The Community Based Seed System (CBSS) is concerned with the production, use, saving and exchange of seeds among the farmers, which is constrained by: lack of modern seed production technologies; climate change vulnerability; insufficient investments; inadequate infrastructures, marketing and processing facilities; and lack of government incentives and supports to CBSS. The seed systems can be strengthened through: i) Developing high yielding and stress tolerance crop varieties; ii) Awareness creation to farmers to use improved seeds; iii) Capacitate farmers on improved seed production and management; iv) Provide community/ group fund; v) Strengthen the seed value chain; vi) Develop infrastructures and marketing linkage; and vii) Develop accredited seed testing laboratory. Efficient seed systems, particularly strengthening the CBSS could contribute to increase crop's productivity that eventually improve the food and nutrition security.

Keywords: Seed system, seed testing, accreditation, Bangladesh

1. Background

Bangladesh is a lower-middle income country located in South Asia with over 159 million populations on a landmass of 147, 570 km^2. Agriculture plays a key role as a main supplier of food source for livelihoods, growth and employment; almost half of Bangladeshis are employed in this sector. Quality seeds are inevitable to meet the challenges of ever increasing population and food security. The CBSS is a delivery system for locally produced seeds that is produced, stored, use, and exchange among the farmers in the community, which is imperative for enhancing crop diversification and resilient to climate change. As the climate change is the most burning challenge, particularly in the developing countries, the adverse effects can be reduced by adopting the climate smart agriculture consisting of developing stress tolerant and high yielding crop varieties, developing innovative technologies consistent with changing climate, creating the enabling policy environment, and building capacity on adaptation and mitigation to climate change (Shrestha, 2019). The availability of, and access to, quality seeds of a diverse range of adapted crop varieties at affordable price and at the time of plantation is essential for achieving food and livelihood security and for eradicating hunger, especially in developing country like Bangladesh. Strengthening both formal and informal seed systems is therefore an integral part of the sustainable use as stated in the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) (FAO, 2009).

Appropriate policies are crucial for creating an enabling environment for seed sector development and facilitate the use and exchange of seeds. The absence of well-designed seed policies and appropriate consultative mechanisms lead to inconsistent decision making which, in turn, limits the capacity to provide farmers with adequate access to quality seeds and planting materials of adapted varieties. Therefore, this paper assess the situation of seed systems, constraints and challenges and way forward to strengthen the seed system in line with improving food and nutrition security in Bangladesh.

2. Situation Analysis of Seed Systems

2.1 Area, Production and Productivity of Major Crops

Bangladesh is primarily an agriculture based country. The physical geography of the country is varied by two distinctive features: a broad

deltaic plain subject to frequent flooding, and a small hilly region crossed by swiftly flowing rivers. Total cultivable land of Bangladesh are 8,585,207.4 hectors (DAE, 2019). Rice is the staple food of the country and the major crops are paddy, wheat, maize, potato, jute, sugarcane, brinjal/eggplant, tomato, mustard, groundnut, lentil, mung bean and other pulses, as well as onion, chili and other spices. The area of different major field crops and their production (2017/2018) is presented in Table 1.

Table 1. Production and area of field crops in Bangladesh (2017/2018)

Crops	Area ('000 ha)	Production (tonnes)	Yield (tonnes/ha)
Total Rice	**18,369**	**529.83**	**2.70**
Aus rice	1,075	27.10	2.52
Amon rice	5,679	139.94	2.46
Boro rice	11,614	362.79	3.12
Wheat	352	11.53	3.28
Maize	447	38.93	8.71
Potato	492	103.17	20.97
Jute	758	88.95	11.73
Vegetables	861	159.54	18.52
Oils	724	9.70	1.34
Pulses	819	10.39	1.27
Spices	572	36.12	6.02

Source: DAE (2019)

2.2 Seed Requirement and Supply

The entire seed supply of Bangladesh principally comes from two main seed systems: i) Formal (authorized and organized) seed system; ii) Informal (farmers' seed system) seed systems. It is notable here that there is an interim seed system, call semi-formal—in between formal and informal seed systems in the country.

The *National Seed Policy 1993* (GoB, 1993) in addition to the *Seeds (Amendment) Act 1997*, and the Seed Rules 1998, is aimed at achieving self-sufficiency in food production with a focus on food security enhancement. The Policy promotes stress tolerant seed varieties, such as saline and drought tolerant seeds and supply of high quality seeds of improved varieties and hybrids for the farmers keeping in view to increase Seed Replacement Rate (SRR) from 26% in 2017 to 30% by 2021 (Table 2). The

seed supply and demand of different crops including paddy, wheat, maize, vegetables (Table 2).

The total demand of seeds were 1,251,580 tonnes; while the quantity of supply 327,962 tonnes indicated that only 26% of the seeds were fulfilled and the remained quantity was filled up from farmers' seed system or community seed system. The requirement of jute and kenaf seed was estimated to be 6,400 tonnes and 1,300 tonnes, respectively in 2017 (Siem Reap, 2017).

Table 2. Seed supply and demand in Bangladesh (2008-2018)

Year	Seed Demand (tonnes)	Seed Supply (tonnes)	SRR (%)
2008/09	977,702	199,874	20.40
2016/17	1,327,644	304,258	22.92
2017/18	1,251,580	327,962	26.20

Source: Siem Reap (2017)

2.3 Production of Seeds of Major Crops

Bangladesh Agricultural Development Corporation (BADC) is the main authorized institution of the government for seed production in the country. The seed wing of BADC through 9 projects, 7 activities and 1 Programme implemented for seed production of different major crops in 2017/2018. Crop wise total 140,642 tonnes of seed production in the year 2017/2018 are shown in the Table 3.

Table 3. Production of seeds of major crops in 2017/18

Name of Crops	Production (tonnes)
Aus Paddy (Rice): BR 20,21,24; BRRI Dhan 42, 43, 83. Transplant BR 26; BRRI Dhan 27,48,82,85.	1,707
▪ Aman Paddy (Rice): Short Less 120 days- BRRI Dhan 33,39,56,57, 62,66,71, 75. ▪ Mid (120-135 days): BR-25; BRRI Dhan 34, 37, 38, 49, 52, 70, 72, 79, 80, 87. ▪ Long (135days above): BR 10,11; BRRI Dhan 30, 40, 41, 44, 51. ▪ Late transplant & light sensitive: BR 22 & 23; BRRI Dhan 46, 76, 77. ▪ Less light sensitive & aromatic: BR 5; BRRI Dhan 34, 37, 38.	17,926

▪ Boro Paddy (Rice): Short less than 150 days- BRRI Dhan 28, 45, 74, 81. ▪ Long 160-165 days: BR 17 & 18, BRRI Dhan 29, 50, 58,69.	65,000
Boro Hybrid (BRRI Hybrid Dhan 3 & 5)	915
Total Paddy (Rice)	85,548
Wheat	17,527
Maize	20
Total Cereal	103,095
Potato	33,043
Pulse	2,435
Oilseed	1,195
Jute	723
Vegetables	45
Spice	106
Total	**1,40,642**

Source: MoA (2018)

2.4 Stress Tolerant Variety Development

In Bangladesh, there are two areas that suffered in environmental and climatic stresses: these areas are coastal, and *haor* (wet land) ecosystems. The coastal areas, nearly 0.84 million hectares, are affected by varying intensities of salinity, resulting in very poor land utilization. The average crop yield is very low in the region, which is obvious due to salinity problems, low soil fertility and drought in the dry season. The dominant crop in the coastal area is the local Transplanted Aman rice.

2.5 Development of Hybrid Rice Varieties

Total numbers of hybrid rice varieties approved and registered for commercial cultivation are 175 since 1998 to 2019 in Bangladesh. The 15 hybrid rice varieties developed in Bangladesh includes (BRRI-6, BSMRAU-1 and Private Seed Companies-8). Out of 175 Hybrid varieties, 8.58% locally developed and 91.42% introduced from abroad (Table 4). Among 175 varieties Boro Season Hybrid Rice Varieties are 157, Aman Season Hybrid Rice Varieties are 17 and Aus Season Hybrid Rice Variety is 1.

Table 4. Country of origin of hybrid rice varieties

Country of Origin	Introduced	Locally Developed
China	126 (72.00%)	-
India	33 (18.85%)	-
Philippines	1 (0.57%)	-
Bangladesh	-	15
Total (161)	**160 (91.42%)**	**15 (8.58%)**

2.6 Seed Classes and Source of Seed

In Bangladesh, four classes of seeds—Breeder, Foundation, Certified and Truthfully Labelled Seeds are needed to test result from approved seed testing laboratory. Seed certification agency issue green, white and blue color tag respectively for formal quality seed. Yellow tag for truthful level seeds are used by the producer himself/herself and seeds are informal. As shown in Table 5, white color tag use indicates Foundation Seed, blue color for Certified Seed, ad green color for Breeder Seed.

Table 5. Seed classification in Bangladesh

Class of Seed	Source of Seed	Certification Tag Color	Seed Certification
Breeder Seed (BS)	The BS, which provides the source of the first and the recurring increase of FS.	Green	Seed Certification by SCA following the Field Standard and Seed Standard
Foundation Seed (FS)	The FS shall be the progeny of BS or be produced from FS which can be clearly traced to BS.	White	
Certified Seed (CS)	The CS shall be progeny of FS, the CS may be the progeny of CS provided this reproduction may not exceed three generations.	Blue	
Truthfully Labelled Seed (TLS)	The TLS shall be progeny of FS, CS, Labelled Seed, or any other seed.	Yellow	Seed Quality declaration by the seed producer following the Field Standard and Seed Standard of CS.

3. Seed Trade of Major Crops

Seed trade compose of import and export of seeds of agricultural commodities, which depends on the quantity of domestically seeds produced and the requirement of the farmers. One of the major constraints on access to improved seeds is tariff and non-tariff trade restriction in the South Asian countries that needs to be addressed through harmonizing the seed trade policies among the SAARC Member countries. Recently, there are some initiatives (for example, SAARC seed bank, SAARC seed bank information system, SAARC seed forum, and seeds without borders) have been made among the South Asian countries to access the released improved seed varieties elsewhere in the South Asia region (Shrestha & Thapa, 2019).

3.1 Seed Import

Bangladesh Vision 2021 is a perspective plan to build a middle income and technology-based country by 2021. Out of 22 perspective indicators in the Vision 2021, the most important targets are self-sufficiency and food & nutrition security.

Bangladesh import seeds to fulfill the requirement of farmers' need to enhance productivity and production and increase farm income ensuring that there is no deleterious effects on environment, health and bio-diversity. While importing seeds and planting material, the compliance of the government rules and regulations have been undertaken, so as to prevent entry of exotic pests, diseases and weeds detrimental to Bangladesh. Public and private seed industry are permitted to import limited quantities (limit varied for different crops as decided by the National Seed Board—NSB) of seeds of notified crops for research and adaptability testing purposes.

The decade has also been marked by a transition from open pollinated to hybrid varieties—deriving maximum utilization from the existing land mass. Considering the land limitations in the country, recent trends indicate a shift towards the production of high yielding varieties of both vegetable and rice. The recent expansion of private seed companies has resulted in the engagement of contact farmers into the formal seed production chain. The imported seeds of different crops: hybrid rice, maize, jute and vegetable in 2016 (Table 6).

Table 6. Seed import in Bangladesh (2016)

Name of Seed	Imported Quantity (tonnes)
Hybrid rice seed	996.22
Wheat	0.28
Hybrid maize (Corn)	5,823.50
Jute seed (Tosha)	5,000.00
Kenaf	1,100.00
Vegetable seed	8,505.79

Source: MoA (2018)

3.2 Seed Export

Given the diversity of agro-climatic conditions, strong seed production infrastructure, and market opportunities, Bangladesh holds significant promise for export of quality seeds. Government extended its long-term policy supports on seeds with a view to raising Bangladesh's share of global seed export from the present below 1% to above 10% by the year 2020/2021 (Siem Reap, 2017). Establishment and strengthening of Seeds Export Promotion Zones with special policy incentives are initiated from the government. Bangladesh has joined to the road-map of quality inbred High Yielding Variety (HYV) and hybrid rice export market. Since 2014/15, Bangladesh has been exploring the global export markets for hybrid rice seed, while the quantity of exporting seeds is limited to below 1,000 tonnes. In 2016/17, Bangladesh has developed bilateral agreement with Bhutan and has successfully exported around 5 tonnes of high quality rice seed varieties (Such as BR-26 and BRRI Dhan-28) from the public sector.

4. Seed Release Process

4.1 Varietal Development

Recently, the Government of Bangladesh has given more emphasis to develop new varieties, which will be biotic and a biotic stress tolerant with high yielding and short duration. Bangladesh Rice Research Institute (BRRI) developed submerge tolerant varieties (Table 7): BRRI Dhan 51, 52; saline tolerant variety BRRI Dhan 53, 54, 55, 61 & 67; and drought tolerant variety BRRI Dhan 62, 63, 65 & 66. Additionally, the government also developed BINA Dhan 7, 8, 9, 10, 11 & 12, which is also saline tolerant. BARI developed drought tolerant wheat varieties (like BARI Ghom 24, 25,

29 & 30). BARI Also Developed 4 (four) BT Brinjal, which is fruit fly resistant, late blight resistant potato, BARI potato 47 & 53.

Table 7. Stress tolerance rice varieties developed by NARS Institutes

Stress Tolerant Rice	**Stress Tolerant Rice Varieties Developed by NARS**	
	BRRI	**BINA**
Submergence tolerant rice varieties	Aman season: BRRI Dhan-51* BRRI Dhan-52**	Aman season: BINA Dhan-11, BINA Dhan- 12
Flood tolerant rice varieties	Aman season: BRRI Dhan-51 BRRI Dhan-52	Aman season: BINA Dhan-11 BINA Dhan-12
Drought tolerant rice varieties	Aman season: BRRI Dhan-56, BRRI Dhan-57, BRRI Dhan-66, BRRI Dhan-71 Aus season: Slightly drought tolerant BRRI Dhan- 42, BRRI Dhan-43	Boro season: BINA Dhan-14 Aman season: BINA Dhan-14, BINA Dhan-19 Aus season: BINA Dhan-19
Heat tolerant rice varieties		Boro season: BINA Dhan-14 Aman season: BINA Dhan-14
Cold tolerant rice variety	Boro season: BRRI Dhan-36,	-
Salt tolerant rice varieties	Boro season: BRRI Dhan-47, BRRI Dhan-61, BRRI Dhan-67 Aman season: BR-23 slightly salt tolerant BRRI Dhan-40, BRRI Dhan-41, BRRI Dhan-53, BRRI Dhan-54, BRRI Dhan-73, BRRI Dhan-78	Boro season: BINA Dhan-8, BINA Dhan-10 Aman season: BINA Dhan-8
Non-Saline Tidal areas rice varieties	Aman season: BRRI Dhan-44, BRRI Dhan-76, BRRI Dhan-77	-
Salt, Drought and Cold tolerant rice variety	Boro and Aus seasons: Medium tolerant BRRI Dhan-55	-

Stress Tolerant Rice	Stress Tolerant Rice Varieties Developed by NARS	
	BRRI	**BINA**
Development of Rice varieties for Haor (Wet land) areas		
Rice varieties suitable for Haor (Wet land) areas	Boro season: BR-17, BR-18, BR-19, BRRI Dhan-45,	Aman season: BINA Dhan-19 Aus season: BINA Dhan-19
Development of nutrient enriched Bio fortified Rice varieties		
Zinc enriched rice varieties	Boro season: BRRI Dhan-64, BRRI Dhan-74 Aman season: BRRI Dhan-62, BRRI Dhan-72	Boro season: BinaDhan14(Protein enriched)
Development of Aromatic and Long Slender Fine Rice for domestic and export market		
Aromatic rice varieties	Boro season: BRRI Dhan-50 Aman season: BRRI Dhan-34, BRRI Dhan-37, BRRI Dhan-38	Aman season: BINA Dhan-9, BINA Dhan-13
Export potential long slender fine rice		BINA Dhan-15 in Aman season

Source: Siem Reap (2017)

The National Agricultural Research Systems (NARS) in Bangladesh is composed of BARC (Bangladesh Agricultural Research Council) and 12 Agricultural Research Institutes (ARIs). The variety development, introduction, release, notification and registration procedures have been improved and updated in the draft of the *National Seed Policy, 2017* and *The Seed Act, 2018*.

The institutions in Bangladesh are responsible for varietal development of different crops are: BRRI (Bangladesh Rice Research Institute), BARI (Bangladesh Agriculture Research Institute), BINA (Bangladesh Institute of Nuclear Agriculture), BSRI (Bangladesh Sugar crop Research Institute),

BJRI (Bangladesh Jute Research Institute), SRDI (Soil Resources Development Institute), BFRI (Bangladesh Fisheries Research Institute), BLRI (Bangladesh Livestock Research Institute), BFRI (Bangladesh Forest Research Institute), BTRI (Bangladesh Tea Research Institute), BSRTI (Bangladesh Sericulture Research and Training Institute), and CDB (Cotton Development Board).

4.2 Seed Multiplication

Breeder and Foundation seed of all notified and non-notified kinds and varieties of crops are made available to both public and private sectors on the basis of their technical capacities. The public sector seed industry, BADC, multiply foundation/ certified/ truthfully labeled seeds on the basis of national seed requirement/ demand on its own farms and through contract growers.

4.3 Variety Release

The Ministry of Agriculture, Government of Bangladesh has recognized 80 different crops and officially published in the Gazette two categories of crops: i) Notified-Crops (7 crops); and ii) Non-Notified-Crops (73 crops) for variety development, variety release, notification and registration keeping with a view to maintaining varietal purity, seed quality and seed certification. The notified 7 crops at present are: rice, wheat, potato, sugarcane, kenaf and mesta.

4.4 Variety Registration

In case of Non-Notified Crop Variety Registration Seed Acts No. Sec. 7 should be under Consideration.

4.5 Maintenance Breeding

Maintenance breeding and breeder seed multiplication is to be improved and strengthened at the NARS, and public agricultural universities and private sector. For this purpose, required facilities, equipment, trained personnel shall be provided at the respective public agricultural research institutes, public agricultural universities and private sector.

5. Seed Policies/ Acts/ Rules and Regulations

5.1 Seed Regulatory Framework

The seed sector regulatory framework and quality control system is commenced with the establishment of the National Seed Board (NSB) in 1973 (the Seed Wing—as Secretariat of NSB in 1992), and the Seed Certification Agency (SCA) in 1974 under the Ministry of Agriculture. The NSB is assigned as the Technical Committee for variety development and recommend for release of the variety. Meanwhile, the Seed Promotion Committee is assigned for planning and programming for quality seed requirement and supply.

The National Seed Board regulates the seed system through the following Regulatory Frameworks:

- The Seeds Ordinance, 1977.
- The Seeds Act, 1997 (Amendment 2005).
- The Seed Act, 2018.
- The Seed Rules, 1998.
- The National Seed Policy, 1993.
- Hybrid Rice Variety Evaluation and Registration Procedures, 1998 (updated in 2003, 2007, 2016).
- Seed Health Standard, 2017 (in the pipe line for approval).

Other Regulatory Frameworks are:

- The Plant Quarantine Act, 2011.
- The Plant Quarantine Rules, 2017.
- The Plant Variety and Farmers' Rights Protection Act, 2017 (under active consideration).
- The Biosafety Related Policy, Guidelines.

5.2 Overview of the Seed Act, 2018

In the *Seed Act, 2018*, there is provision of punishment to any person or enterprise who violate the regulation made in the Seed Act. In the Seed Act 2018, the provision of punishment for first offence has been fixed to fine of fifty-thousand (50,000 Taka) and imprisonment for a term of ninety-days or both against the provision of five- thousand (5,000 Taka) and imprisonment for a term of thirty-days imposed in the Seed Act 2005. The punishment for

further offence if any by the same person shall be double or both provisioned in the Seed Act, 2018 against fine of twenty-thousand (20,000 Taka) and imprisonment for a term of ninety-days imposed in the Seed Act, 2005. The Metropolitan Magistrate or Magistrate of the First Class has been empowered to enforce the punishment against person or enterprise violated the Seed Act, 2018 and Seed Quality Standards

5.3 Plant Quarantine Regulation

The *Plant Quarantine Act 2011* (GOB, 2011) is to be applicable for import and export of seeds. However, procedures will be simplified by reviewing the Plant Quarantine Act from time to time to facilitate import and export of quality seeds. Plant quarantine procedures are applicable to crop/ plant species and to specific varieties.

5.4 ISTA Accredited Laboratory

ISTA Accredited Seed Testing Laboratory in the public and private sector will be developed for standardizing the seed quality to export seeds in the global markets.

5.5 Registration of Seed Enterprise

In the *Seed Act 2005,* the seed business was allowed by a person or enterprise in the name of the Seed Dealer, having Seed Dealership Registration with the National Seed Board, Ministry of Agriculture. In the *Seed Act, 2018*, the seed business has been categorized into two: namely i) Seed Industry; and ii) Seed Dealer.

5.6 Regulatory Reforms in Variety Release

In case of notified crops, both public and private sectors have been allowed to avail equal opportunity for development, release and notification of notified crops. In case of non-notified crops, there is not essential of variety evaluation by the Technical Committee of the NSB, provision has been made for the non-notified crop variety to direct registration with the NSB.

5.7 Seed Security

In the seed policy, seed security has been given highest priority by protecting plant genetic resources, germplasm, and seed counterfeit, ensure varietal purity and seed quality (Kolady & Awal, 2017). Public and private sectors play a vital role to maintain stocks of seeds of improved varieties/

hybrids Notified Crops. So that the quality of seeds can be distributed to the smallholder famers in natural disasters.

5.8 Regulatory Body and Functions in the Seed Sector

The function of regulatory body (referred to 5.1) includes: i) Identifying promising lines with preferred traits for further evaluation from advanced variety trials; ii) Testing of new promising lines to identify traits through evaluating the Distinctness, Uniformity and Stability (DUS); performance evaluation from farmers point of view—by evaluating Value for Cultivation and Use (VCU) through the SCA in case of notified crops; iii) Technical evaluation of promising variety by the Technical Committee of the NSB to recommend to the MOA for approval, release and Officially Notification by the Ministry of Agriculture in case of Notified crops; iv) Registration of newly developed variety with the NSB fulfilling varietal descriptors in case of non-notified crops; v) Inscription of the officially released varieties in the National Variety Catalogue of the Ministry of Agriculture; and vi) Making available quality seeds of new varieties for further multiplication, distribution and marketing to the farmers.

6. Projects on Seed Sector Development

Both the government and the private sectors are working for quality seed supply for the farmers. Government has been extending its initiatives through different projects, programs and special activities for small and marginal farmers. In 2010, FAO started an "Integrated Agricultural Productivity Project (IAPP)" and formed 198,214 farmers' organizations/ groups in the country. Private sector also have extending their efforts of quality seed production by contact farmers.

Formal quality seed production and supply through government levels are:

6.1 Bangladesh Agricultural Development Corporation (BADC)

In 2017/18, there were 9 projects, one program and 7 special activities conducted for producing quality seeds. Under this scheme, about 12,375 farmers obtained trainings on quality seed production, storage and distribution.

6.2 Department of Agricultural Extension (DAE)

Three projects are being implemented for the farmers' quality seeds production throughout the country in 2017/18. The main commodities and achievements are as follows:

- Production, Storage & Distribution of Quality Seeds through Modern Technologies of Rice, Wheat & Jute at Farmers' level. Under this project, 9270 farmers received training about technology of seed production. It is estimated that about 20,400 farmers will be trained through the project and produced 5,933 tonnes of quality seeds in 2019/20.
- It focuses Production, Storage & Distribution of Quality Seeds of Pulses, Oil & Onion at Farmers' level Project. In 2017/18, about 19,560 farmers received training about technology of seed production.
- In the 3rd phase of the project, production of quality seeds for pulse, oils and spices are emphasized. Further, storage of the seeds and distribution to the farmers' level are the major components. Under this project, 5,310 farmers received training about technology of seed production and 2,284 Mt of quality seeds were produced.

7. Successful CBSS in Bangladesh

In addition to the government institutions i.e. BADC and DAE, Rural Development Academy (RDA), Bogura and Bangladesh Rural Advancement Committee (BRAC), some Private Seed Companies (For example, Lal Teer, Supreme Seed, Metal Agro etc.) and NGOs have also been working on improving seed systems. Recently, Bangladesh is advancing in seed sector through government's initiatives with subsequent policies and program supports. However, the informal seed supply is dominant, estimated to be 74% of the total seed used by the farmers. It is obvious that the quality seed supply will increase by at least 10% within a short period through strengthening Seed Certification Agency (SCA). Maria Model is one of the successful model for seed system in Bangladesh. Detail characteristics and achievements of this model in the seed system is as follows:

Maria Model

Maria Model is developed by Dr. A. K.M. Zakaria, located in Maria Village, Shahjahanpur Upazilla, Bogura, Bangladesh. It involves about 30 farmers'

households and produced rice seeds about 25 tonnes annually. The program activities of the Maria are: seed production, storage, marketing and micro-credit. The business model adopted—the dealer linkage and direct sell networking with formal and informal institutions: RDA, DAE and SCA. The model has been adopted for System of Rice Intensification (SRI) approach. This model has been expanding towards the smallholder farmers for climate change resiliency, biodiversity conservation and food nutrition security. The farmers in the nearby village try to follow this model. Recently, farmers have started to produce vegetable seeds with this Maria Model. This Maria Model has been showing its performance to contribute in improving the food security by supplying good quality rice seed in the Maria village. The constraints and policy suggestions for the Maria Model are as follows:

Constraints in Maria Model

- The participation of female members is limited as they have difficulty to take part in direct selling of seeds.
- Lack of government policy and program supports and legislation to strengthen seed systems under such model.
- Farmers are handicapped by non-availability of transport, market linkage and storage facilities.
- Insufficient climate resilient varieties, early warning system and crop insurance support are the major challenges faced by farmers.
- Funding unavailability and distribution of improved seeds for all farmers, especially poor farmers.

Suggested policies to strengthen Maria Model

- Policy and legislative supports to formalize the seeds produced in the CBSS with certain standardized procedures in registration and release process.
- Subsidize the seed processing equipment, particularly harvesting, drying, grading, packaging and storage.
- Training on improved seed production technologies.
- Easy accessibility of improved seed varieties with subsidy or loan funding for small and marginal farmers.
- Promote crop/ seed insurance program to reduce the farmers' risk from externalities.

- Establish strong linkage of CBSS with market outlets and institutional seed end users.

8. Constraints/ Challenges and Opportunities

The seed sector is constraints in following areas:

i) Seed production— quality seed production of the major crops should be increased for sustainable self-sufficiency and reduce the seed demand-supply gap.

ii) Seed sector is mainly constrained by lack of storage, processing and preservation facilities. BADC has seed storage facility having capacity of about 1, 50,000 tonnes of seed. Private sector and NGOs have very limited programs and resources for strengthen seed sector. Due to the shortage of seed storage facilities, farmers are not getting improved seeds during cropping season.

iii) Human resource development—skilled manpower (seed producers, technicians, traders and companies) for seed production is one of the constraint in seed system in Bangladesh.

iv) Seed certification—in case of truthful labeled seed certification, the seed producers need more skills and knowledge about seed production. So, the farmers and seed certification agency should be strengthening and capacitate the updated technologies.

v) A larger proportion (74%) seeds are covered by informal seed, while there is not provision to certify of such informal seeds. The seed testing laboratory should be strengthened and facilitate to test the farmers' seeds.

vi) Seed Health Standard—seed testing system should be established for testing of seeds health standard of the public and private sector for quality assurance of seeds. National Seed Health Committee (NSHC) would be established to monitor the seed health standard following the guideline of ISTA (International Seed Testing Association), IRRI Seed Health Standard and other International Seed Health Standard of the world.

9. Recommendations

Based on the discussion above, the following recommendations are derived to strengthen the seed systems in Bangladesh.

i) The research centers/ institutes related to seeds and biotechnology should be well equipped and capacitated to develop new crop varieties that should have high yielding and biotic & abiotic stress tolerance characteristics.

ii) Awareness should be created among farmers about the quality seed production and use. For this, the seed related government agencies to be strengthened and massive training facilities to be provided to the famers and concerned stakeholders in the seed value chain.

iii) Incentives and supports for both public and private sector's seed production and marketing should be provided. Easy access to bank loan for poor farmers to be given; as a result, farmers will be able to use improve seeds.

iv) Rules, regulations and procedures for import of seeds should continuously be revised and adjusted as per required. Seed trade barriers, particularly the tariff & on-tariff should be resolved appropriately.

v) Effective and functional coordination should be established between public, private, NGOs and Farmers organizations sectors.

vi) Highly popular varieties of rice & vegetable seed should be available by exchanging mechanism among the countries in South Asian.

vii) The governments should have the top priority and allocated adequate resources to develop the new seed varieties with high yielding, biotic and abiotic stress resistant characteristics using the traditional traits.

10. Conclusions

Quality seed is one of the first and foremost prerequisites for a healthy and vigorous crop that would have significant contribution for food and nutrition security. As the formal seed system covers very low percentage, the informal seed system, particularly the farmers' seed and community-based seed system need to be strengthened with the government's policy incentives and necessary supports. In order to feed the growing population, we need to come up with the holistic approach where the breeders, seed technologists, farmers and policy makers will appropriately play their role for making quality seed available to the farmers. The national agriculture policy should be evaluated and reviewed in the context of overall economic condition and the changing agricultural production system. Good seeds alone can give an increased production to the extent of 20-25% over the

poor quality seeds varieties. For that reason, the private sector need to be strengthened through transfer of technology and providing breeder and foundation seeds with minimum Government Control. As a result, many private seed companies, which can be managed or led by family farmers, will be developed to produce and supply improved seeds to the smallholder farmers in Bangladesh.

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Country Perspective Paper

Chapter 7

Strengthening Seed Systems for Improving Food and Nutrition Security in Maldives

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Abstract

The economy of Maldives is driven by tourism industry and the contribution of agriculture sector was 1.8% of the GDP in 2017. In 2019, about 7,536 people have been officially registered as farmers. The most common grown crops in the country are coconut and chili, followed by banana, papaya, mango, guava, watermelon, eggplant, collard greens, passionfruit, breadfruit, wax apple, pond apple, custard apple, cucumber, betel leaf, betel nut, and tubers like taro, sweet potato and cassava. Saving seeds for the next crop is not a common practice even for the short-term crops like vegetables, watermelons and papaya. Vegetable producers are completely relying on imported hybrid varieties of seeds due to its high yield and appealing look. Several indigenous varieties have been lost during the transformation of Maldives' economy. Again, today there is a threat of losing economically important locally sourced varieties, if necessary measures are not taken. Community Based Seed System (CBSS) is essential for Maldives to protect the remaining few local varieties for future generations as well as to develop improved varieties that could assist farmers to adapt to the impact of climate change.

Keywords: Seed sector, access to seed, smallholder, agricultural land use

1. Background

The Republic of Maldives is the only country in South Asia that consists of several islands and the smallest in terms of geographical coverage in the region. The low-lying islands of Maldivian archipelago is scattered into an area of 895,000 km^2 (ADMP, 2006). The agriculture is an important sector for Maldives in terms of poverty alleviation, improving health and nutritional status of the people, generating employment and minimizing the dependence on food imports. However, geographic nature of the country

hinders development of domestic agricultural production. The total land area of the country geographically stretches over 1,192 islands, each of which are less than 1 km^2 in average and are subject to change its size, shape and elevation over time. Majority of the islands are lower than one meter above sea level (Weerakoddy, 2008).

Maldives is geographically located in the Indian Ocean across the equator neighbouring India and Sri Lanka. The archipelago is known and famous among tourists as a tropical paradise. However, the tropical nature is not favourable to crop producers as the agro climatic conditions are hospitable to pest and diseases to the crops grown. Use of synthetic fertilizers and hazardous chemical pesticides have become increasingly common over the past few years. The excessive use of such chemicals has been interrupting the unique and fragile ecosystem and biodiversity, severely affecting the natural regulation of pest control.

The contribution of agriculture sector to the national economy has been declining over the past few decades. Agriculture sector shared 7% of the GDP in 1984, dropping to 3.5% in 1995 (Weerakkody, 2008) and further declined to 2% in 2009 (NSB, 2009). Again in 2017, GDP share of agriculture fell to just only 1.8% (NBS, 2017). Despite the continuous decline in agriculture sector's contribution to the economy, the dependence on agriculture as a livelihood of island communities remains significant.

2. Agricultural Land Use and Major Cropping Patterns

Land area available for crop cultivation is relatively small. The total area suitable for cultivation is approximately 2670 hectares (FAO, 2005). These lands are fragmented and distributed among number of islands that are scattered in the vast Indian Ocean. About 7,536 farmers from 77 uninhabited islands were registered in the Ministry as of July 2019 (MOFMRA, 2019a).

So far, commercial agriculture is being practiced in 50 uninhabited islands leased by government solely for this purpose. Commercial crop cultivation is also done in another additional 8 islands that were leased for both commercial agriculture and fisheries related activities (MOFMRA, 2019b).

In addition, the soil of Maldivian islands is made up of coral sands. The depth of fertile top soil layers are generally shallow and vary between islands ranging 6 to 9 inches (Butani, 1974). Due to high porosity, the water retention capacity of the soil is extremely low and soil pH is highly alkaline with an average of 8.5 (Palengleng, 2007).

In spite of the challenges, crop cultivation is practiced to some extent in almost all inhabited islands of Maldives. Backyard gardening with mixed crops is the most common type of farming practiced in the inhabited islands. They include, permanent and semi-permanent crops such as coconut, breadfruit, guava, wax apple, custard apple, pond apple, mango, banana, papaya, betel nut, betel leaves and some cash crops like, chili, eggplant, passion fruit, collard greens, pumpkin and watermelon. Moreover, sweet potato, cassava, yam and taro are some of the root crops popular among farmers. The plots for farming are leased by island councils that ranges in size from 1000 to 10,000 ft^2 (Palengleng, 2007).

3. Seed Systems

At present, no formal mechanism is established in Maldives for seed production and distribution to the farmers. Almost all vegetable seeds (except coconut, chili, pumpkin, passionfruit, breadfruit, pond/custard apple and few root crops like taro, cassava, and sweet potato) are of imported origin and are mostly expensive hybrid varieties. These are preferred by farmers mainly because of unavailability of good quality local seed varieties. Though, most hybrid seeds imported are of good quality, they are often not developed for Maldives climatic and soil conditions. Due to this, the crops even though are high yielding can face acclimatization issues and require large quantities of synthetic fertilizers. Also, the Ministry of Fisheries, Marine Resources and Agriculture (MOFMRA)'s Extension Officers highlight the significant increase in pest and disease incidents associated with commercially grown hybrid crops.

National seed system is an integration of combined activities such as plant breeding/ varietal improvement, community-based seed supply, commercially oriented seed supply, plant genetic resources conservation and use as well as regulate the seed production, quality and security (FAO, 2019). Although seed is the basic and most essential element for a crop production, the national seed system has not been established yet in Maldives and these may be due to various reasons—limited land, relatively small-scale of crop cultivation in island communities, pest and diseases, low yield, poor handling and storage conditions of seeds are some of the many challenges faced in establishing a national seed system.

4. Needs of a Community Based Seed System

According to the agricultural survey and crop production report on Maldives published by FAO on 1974 (Butani, 1974), maize and sweet potato contributed to 75% of Maldives food requirement. The absence of good quality seeds and planting materials of maize and sweet potato was highlighted in that report and was also recommended to establish mechanisms in north and south of Maldives for enriched seed variety development and provision to farmers (Butani, 1974). Unfortunately, soon after the beginning of rice imports in bulk quantities during the 70s, maize cultivation came to an end and the local varieties of maize, sorghum and finger millet has completely disappeared.

Today, coconut can be considered as the most extensively grown crop in Maldives and until very recent most of the coconut varieties found in Maldives islands are locally sourced. Consumption trend of coconut have changed over the past few decades. Matured coconuts used to be the main products traded in local markets as they are one of the most common ingredients in local food. With the increase of tourist arrival, demand of young coconut increased drastically and it catches better price than matured coconuts. Due to early harvest, coconuts no longer remained in the palms to reach its full maturity. In parallel, farmers started to look for coconut varieties beyond the attributes of better yield such as bearing fruits at a low height and starts fruiting within a short period of time. Ultimately farmers started growing improved imported coconut varieties. It is now the time to think of the future of local coconut verities as they are no longer preferred by farmers. Local varieties need to be further developed to attract local growers. Unlike other crops, coconut groves occupy larger area of land and due to the high demand for younger coconut it may not be easy to convince local coconut cultivars to produce seeds by themselves. However, at this point it is essential to develop farmers' knowledge and capacity to enhance the performance of local varieties in order to safeguard what remains of this genetic wealth.

Local chili, "Githeyo Mirus" (*Capsicum Chinense*) is one of the most rewarding as well as the most preferred cash crop in Maldives. This variety of chili is highly susceptible to common pest and diseases in the high humid tropical climatic zones. It also requires high maintenance as well as almost all essential nutrients' supplement. Despite all these challenges, farmers have managed to maintain the same variety by using seeds from the crops grown

in previous season. Unfortunately farmers either do not have the sufficient knowledge and skill or do not have the habit of storing seeds for longer period. In the event where farmers lose their crops due to heavy rainfall or draught, they collect seeds from the chilis bought from nearby market without realizing the attributes of its parental crops. These habits have led to incapacitate the local "Githeyo Mirus" variety.

Banana is another important crop widely grown in many agricultural islands. Despite the fruit becoming smaller in size and low in yield, farmers have continued to cultivate the local banana varieties. Nonetheless, banana production is far below the local demand. To cater to the demand, 1,053 tonnes of banana was imported to Maldives during the first five months of 2019. Banana is one of the crops included in the list of five crops chosen for the import substitution program. Financial assistance and technical support are being provided the commercial producers to increase the production of banana, watermelon, papaya, pumpkin and cucumber—all five crops in the import substitution program. To support the school breakfast program initiated by the Ministry of Education, MOFMRA provides tissue culture Cavendish banana plants to parents of school children as well as display a plot of banana garden for demonstration at the schools' premises.

Unlike the local banana varieties, Cavendish banana is bigger in size, taste and texture are more preferable, and yield is much higher. Therefore, there is a possibility for farmers to avoid existing local banana varieties soon after the improved Cavendish varieties are widely used. Furthermore, CBSS is essential for the island communities, especially in the islands where farmers completely depend on local chili production.

5. Area, Production and Demand for Seeds

Coconut being the most extensively grown crop in Maldives, are found in almost all islands and it is one of the major income sources for many people living in island communities. In most islands, coconut groves are naturally grown and are not managed well by the beneficiaries. Over the past few years rapid decline of coconut harvest is being observed across the country. The yield has been decreasing due to the rising number of over aged palms as well as mismanagement of coconut groves. Also, the infestation of pests and diseases like Rhinoceros Beatle and Coconut Hispid Beatle adds to the list of main causes of low yield.

Since Male', the capital city is the main commercial hub, it is believed that market data collected from Male' could provide clear indication of agricultural production nationwide. However, with the expansion of tourism industry and transformation of transportation nowadays, a considerable number of agricultural products are being traded within the atolls through the newly established ferry transport mechanism. Significant proportion of agricultural products are also channelled directly to resorts in some atolls, especially where the resorts are connected by ferry transportation. New regional markets have also emerged and have become popular among producers and consumers among that specific region. Kulhudhuffushi regional agriculture market is one among them, to which farmers from nearby agricultural islands gather with their produce on every Saturday. With all these changes in marketing agricultural produce, to get a clear picture of agricultural production nationwide, it is no longer advisable to rely on the data collected simply from Male' market.

Table 1. Agricultural products traded in Male' Market

Produce	Quantity (tonnes)		
	2016	2017	2018
Watermelon	438	395	201
Coconut (Young)	1,601	1,068	817
Coconut	272	224	83
Papaya	574	652	678
Pumpkin	164	131	73
Cucumber	127	81	96
Banana	589	556	124
Eggplant	128	70	50
Chili	74	53	23
Chinese Cabbage	76	61	71
Mango	48	16	47
Betel leaf	44	44	33
Total	4,729	3,351	2,296

Source: MOFMRA (2019c)

A significant decline was observed in mango trade in 2017 (Table 2). This was due to the fruit fly infestation that was reported from one of the major 2 mango producing islands in the country. Strict measures were taken place by MOFMRA as soon as the pest was reported. Island councils and producers were advised not to take mangoes out of these islands until further notice.

The produce was kept in total isolation and pheromone trap was introduced to those islands to trap fruit flies. It was one of the most successful pest control operation that took place in the recent agricultural history of Maldives. As no symptoms of fruit fly were observed in the next mango season, the affected producers were allowed to resume trade of their mangoes to other islands in the following season.

The import statistics published by Maldives Customs Services revealed that around MVR 2 million[1] is spent on seed imports every year (Table 2). This means MVR 749 on average is spent on seeds to do cultivation in each hectare of available land during a year. These imported seeds are solely of hybrid varieties and are generally sold in agriculture input supplier shops located in Male'.

Table 2. Imports of seeds to Maldives 2017 to 2019

Year	Vegetable Seeds (Sowing)		Other Seeds (Sowing)	
	Quantity (tonnes)	CIF Value (MVR)	Quantity (tonnes)	CIF Value (MVR)
2017	6	730,846.52	11	1,266,994.64
2018	3.2	800,298.40	16	1,851,093.61
2019 (Jan to Sep)	1.2	455,249.22	32.2	1,659,999.90

Source: MCS (2019)

6. CBSS Contribution to Smallholder Agriculture and Food & Nutrition Security

Most smallholder farming systems around the globe have the habit of storing seeds and using them during the next season. Surprisingly this informal seed system is practiced in much advanced farming systems, like wheat producers in United States (Minot & Smale, 2007). Seed is a vital resource that has potential to deliver advanced solutions that eventually benefits to small holders such as enhancing productivity, nutrition and resilience to climate variations and pest and disease control. It can play a vital role in the introduction of new and diverse varieties, allowing farmers to achieve higher yield with minimal expenditure on inputs. New seeds are often developed with traits that enrich nutrition (Bouis & Welch, 2010) and climate variations are addressed through improved seed with the attributes like tolerant to

[1] *Maldivian Rufiyaa (MVR) is Maldives currency (1 US$= 15.42 MVR).*

stresses: salt, heat and cold (McGuire & Sperling, 2013). Such varieties are mostly supplied through public and private companies that are operated in a more formal manner.

Improved crop varieties do not always perform the way it was intended to. It is evident that around the world, agricultural biodiversity is greatly obstructed by the introduction of new crop varieties (Petit et al., 2001). In some cases, the new variety lacks farmers' requirements or it does not adapt well to the local agro-climatic conditions. Smallholder farmers could play an important role in increasing diversity of locally grown crops. However, it requires recognition and additional support from the government. On the contrary, in many countries local/ traditional seed varieties are portrayed as "backward and low yielding". Instead of promoting resource conservation and sustainable use of agricultural biodiversity, government policies of most countries are designed to promote economically feasible export oriented agricultural production systems (Bioversity International & CGIAR, 2016).

The CBSS can be very useful for the smallholder agriculture communities based in small islands as each island have its unique agro-ecological features. If the seeds could be developed with desirable features locally, it could reduce the cost of agricultural production as huge amount of money is spent on buying imported seeds. Money spent on supplementary nutrients and pesticides can also be reduced if the varieties grown are local and suits the growing conditions.

Farmers' choice of crops for cultivation depends on market demands. In order to drive farmers towards the cultivation of crops that are important for the food security requirement, it is important to advocate consumers to incorporate certain commodities in their daily foods. For instance, until 1970s Maldivians were producing enough food for the whole community. At that time maize, sorghum, finger millet, breadfruit and some root crops like sweet potato, taro and cassava were the staples of Maldivian diet. Even though these staples fulfil the food security requirements, these were substituted by rice and wheat. The change in lifestyle and food habits have made us forget to save such vital indigenous resources that once served as staple food to our future generations. Today rice and wheat have dominated our main diet and we can rarely find the diverse sources of carbohydrates on our dining tables.

Maldives is one among the most vulnerable countries to the adverse effects of climate change. Salt water intrusion is becoming common in many islands while rain fall patterns have been changing every year. Extended heat

seasons getting prolonged and pest and disease incidents are more alarming than it has ever been in the near past. The challenges related to climate change faced by Maldivian farmers can be more or less same as those faced by its South Asian counterparts. However, the impact of climate change could be more severe in Maldives due to the fragile and unique geographic nature and ecosystem.

Maldives being a small island nation, with limited land and scope for agriculture, makes it less attractive for businesses to invest in developing seeds having exact desirable features in a commercial scale. Given this into account, it might be to start seed production at least at a smaller scale within the local farming communities.

7. Policies on Seed Systems

Government policies are generally formulated upon the demands from people and community. Farmers often complain about the limited market access for their produce and rarely discuss the issues related to seeds. Therefore, most of the policies are derived to address those challenges as well as to provide financial and technical support to farmers.

Ecological resilience is one of the main pillars of the policy document under enforcement at the moment. One of the key strategies under this pillar is to promote and facilitate access to programs, tools and equipment that can contribute to biodiversity protection as well as effective control of plants (MOFMRA, 2019a). The actions under this strategy ensures the programs and activities are environmentally sound and sustainable. Although agriculture development policies are aligned with sustainable development goals, due to several reasons discussed above, domestic production of seeds and its supply have never been promoted. On the other hand, improved varieties of imported seeds have been introduced to farmers on several occasions. On contrary to the previous Strategic Action Plans (SAP), the SAP of the ongoing presidential term which lasts five years from November 17, 2018 has emphasized on the importance to regenerate the indigenous local varieties with high nutritional values.

Since Maldives is an import-oriented country and most of the seeds used in agriculture being imported, are well regulated under the Plant Protection Act of Maldives (12/2011). Plant and Animal Quarantine Diagnostic Centre (PAQDC) under MOFMRA is the responsible agency to implement this Act.

Imported seeds are inspected at the port of entry and ensured that the following criteria is met:

- Seeds are packed, properly sealed and labelled in English.
- If seeds are treated, information on treatments including the chemical name and quantity used in the treatment is shared.
- For grass seeds, germination percentage and other relevant documentation must present with the consignment.
- Seeds are free from soil.

It is essential to understand the current situation of informal and formal seed systems in Maldives through a detail analysis. In order to support the development of such systems, it requires facilitation through regulatory frameworks by outlining key steps and guiding principles in the relevant laws, regulations and national policies.

8. Way Forward

Farmers require additional knowledge and skills to multiply seeds without losing its valuable and highly desirable traits. It is also important to make farmers understand that new and improved seeds are not always necessary to address challenges. Some of the challenges like pest and diseases can be managed by simply having a mix of appropriate crop diversity in the field. Additionally, it is necessary to make farmers aware of some of the traditional species that are often neglected by smallholders that have a greater potential in improving food and nutritional security of the community. Such under-utilized crop species with high nutritional value need to be identified and promoted among farmers.

It is understandable that seed production for all the crops enough to cater famers demand may not be possible for a small island nation like Maldives. However, existing informal seed production systems of specific crops like local chili "Githeyo Mirus" could be promoted and enhanced further. Also, farmers are to be trained on seed quality improvement, storage and distribution techniques and encouraged to produce seeds of enriched quality. In parallel other supports like improving storage and distribution conditions as well as establishing proper linkages among farmers are necessary. Furthermore, it is compulsory to increase awareness among seed suppliers on introducing varieties that have capacity to adapt to cropping conditions without compromising the agricultural biodiversity.

The existing policies and legal framework must be further strengthened to promote the use of locally produced traditional and improved varieties such that the agricultural biodiversity is conserved and sustained.

9. Conclusions

Until the mid -1970s Maldivians were self-sufficient on maize sorghum, finger millet, sweet potato, taro, breadfruit and coconuts. All these were grown locally and farmers had the habit of saving seeds to be used in the upcoming season. Following the wide acceptance of rice and wheat into the food system, traditionally grown crops were abandoned transforming the agriculture system with other types of fruits and vegetables.

Currently, Maldivian farmers do not cultivate staple food items. They grow fruits, vegetables and root crops. Instead of producing seeds by themselves, farmers always look for good quality seeds and almost all the farmers depend on imported hybrid seeds sold by agriculture input suppliers.

The CBSS is important for Maldives to best manage pest and diseases and conserve biodiversity unlike the imported hybrid seeds that do not suit well in the island ecosystems. Without CBSS, farmers have no choice but to spend more on supplementary nutrients. CBSS could be the best alternative for Maldives to retain the limited genetic resources that remains as well as to develop improved varieties that could perform well in the unique Maldivian agro climatic conditions especially during times of climate change.

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Country Perspective Paper

Chapter 8

Strengthening Community Based Seed Systems for Improving Food and Nutrition Security in Nepal

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Abstract

Community Based Seed System (CBSS) is the best approach for sustainably available of quality seeds to the smallholder farmers. Evidence showed that District Seed Self Sufficiency Program (DISSPRO), Community Based Seed Production Group (CBSPG), Community Seed Bank (CSB) and small seed enterprises are effective institutions for conserving local varieties and providing easy access to diverse type of seeds and planting materials to the farmers in Nepal. Recently, the private sector has been greatly engaged in the seed systems, especially in import and distribution of hybrid seeds in the country. Seed acts, rules and regulations, guidelines, programs and projects are focused for seed production and marketing as well as strengthening the community based seed institutions. The CBSS is complementary to the conventional seed system, which provides good opportunity for farmers' organizations to improve the supply of quality seeds to the communities and develop in to viable seed enterprises. Main constraints of CBSS are inadequacy of quality seeds, unaffordable price of hybrid seeds, inadequate storage structures, limited subsidy for inputs, and climatic calamities. However, the seed system can be effective and efficient by giving highest priority from the government, and consolidating seed initiatives with optimum allocation of resources that could contribute to enhance productivity of crops and improve food security.

Keywords: seed system, DISSPRO, CBSP, CSB, OPV, SRR, Nepal

1. Background

1.1 Agriculture System

The Nepalese agriculture is characterized by integrated and complex farming systems characterized by fragmented and small landholdings, subsistence, low productivity, monsoon dependence, low level of technology, disguised employment, labor shortage, weak extension services, low mechanization, weak infrastructures and transportation, warehouses and weak markets. However, the agriculture sector is a source of food security and a major means of livelihoods for 60-65% of the population. The cropping pattern of Nepalese agriculture varies according to the agro ecological zones and irrigation availability. The rice-wheat cropping pattern is predominant in the *Terai* belt while maize based system is popular in the hilly areas.

Food grain production, particularly in the hill and high hill areas is not enough to feed growing population. Even in the *Terai* region, the food basket of the nation, all districts are not food secured. About 39 districts are surplus in food production and the remaining 36 are food deficit (MOAD, 2018). The cereal crop yield is low mainly due to poor quality seeds uses, imbalance and less quantity use of chemical fertilizers (58kg/ha), rainfed nature of irrigation and low rate of adoption of modern technologies. Though there is increasing trend in production and productivity of agricultural crops (Table 1).

Table 1. Area, production and yield of major crops in Nepal

Crops	Area (ha)	Production (tonnes)	Productivity (tonnes/ha)
Rice	1,469,545	5,151,925	3.51
Maize	954,158	2,555,847	2.68
Wheat	706,843	1,949,001	2.76
Pulses	311,382	368,741	1.18
Oilseeds	2,245,867	245,867	1.09

Source: MOAD (2018)

1.2 Seed System

Seed is a primary and vital input in agriculture production. Access to quality seeds to the farmers is a necessary condition for enhancing productivity. The seed sector development is more feasible in the country because of its diverse production environments, which range from the flat plains of *Terai* in the

south to the sloppy terrains of the hills and mountains in the north. Studies revealed that the use of improved quality seeds alone can result in 20-30% increase in yields, depending on crop varieties and management practices (CDD, 2015). The current levels of Seed Replacement Rate (SRR) hovering 16.6% for major cereals (rice, maize and wheat) (Table 4) indicating that there is wider scope of adopting improved seed varieties and prospects of increasing crop yields and foods in the country. Open Pollinated Varieties (OPVs) dominate the area under cereal crops (LI-BIRD, 2017).

The formal seed sector (government and private companies) supply around less than 20% of the total seed requirement of cereal crops in Nepal. However, this sector is constrained by lack of adequate investment, limited qualified manpower and weak modern infrastructure facilities. More than 80% farmers used their own seeds; they produce, harvest, process, handle, and store for the next cropping season. Efforts are underway from both government and non-government sectors to increase the SRR by increasing access to new seed, raising awareness, capacity building and motivating farmers' groups, cooperatives and companies in seed production and marketing.

Broadly two seed systems are recognized in Nepal, i.e. informal and formal systems. Informal seed supply system is also known as "Farmers' Seed System". The informal seed supply systems are characterized by farmers producing and preserving their own seeds for subsequent planting season. Farmer cultivate seeds and planting materials, select, store, use, sell and exchange among them-self over the generation for their livelihoods. Local landraces are important for household food security of subsistence farmers as well as for developing improved varieties. It is important for the smallholders those who have limited capacities to invest on purchased inputs and technologies. Strengthening the farmer's seed system in Nepal is vital and sustainable way to provide quality seeds to the farmers for preferred crop varieties, which would eventually contribute to improving food and nutrition security of smallholder farmers.

The concept of Community Based Seed Production (CBSP) system evolved in 1990s as a response to the failure of Private Seed Companies and Government Seed Corporations' to supply diverse rice varieties in cheaper price in the rural areas. In this system, farmers' organized in groups or cooperatives (synonymously referred to as Community Based Seed Producer Organizations (CBSPOs) produce seed at household level. Such institutions

are accessed to inputs and outputs marketing through CBSPOs. There are 128 registered CBSPOs involved in production and marketing of cereal seeds and majority of them (more than 80% are operational in the Tarai region).

There are two good practices currently functioning i.e. Community Based Seed Producer Groups (CBSPGs) and Community Seed Banks (CSBs). The concept of CBSPGs started during late 1990s by the Department for International Development (DFID) funded Participatory Crop Improvement Projects, which was implemented by LI-BIRD that contributed to improve the technical, marketing and infrastructural capacity in Nepal. Nearly four dozens CBSP groups have been initiated since late 1990s and over time those groups evolved into different forms, e.g. as cooperatives and also as private seed companies. Recently, these institutions are engaged in producing and marketing of Truthfully Labeled (TL) and other classes of improved seed varieties in the country. CBSPGs have good linkages with District Agriculture Development Offices as well as with Seed Quality Control Centre of the National Seed Board. These linkages are very important for accessing source seeds, for seed certification as well as market linkages and networking. These initiatives have greatly increased the access of new seed varieties to the farmers. Another good practice i.e. CSB work range from Plant Genetic Resources (PGR) conservation, dealing with PGR and improved varieties to commercial production and sale of improved seed varieties. It is crucial to strengthen local capacity to produce, multiply and manage adequate quality seeds that could provide a sustainable model for community-based management of PGR (Shrestha et al., 2012). However, CBSs are encountered several challenges, which needs policy incentives and supports for achieving expected results in sustainable availability of improved seed to the smallholder farmers (Bhattarai et al., 2016).

District Seed Self Sufficiency Program (DISSPRO), CBSPGs and Community Seed Bank (CSB) are effective institutions for conserving local varieties and providing easy access to diverse types of seeds and planting materials to framers. When conservation activities of local varieties are coupled with income generation activities, CSB can operate more successfully in the long run. Establishment of a CSB can best be started when community people are convinced about its role in seed security, food security and conservation of valuable plant genetic resources. CDD (2015) reported that 144 CSBs were established in 2014, while only 44 CSBs are active in 2018 (NAGRC, 2019). The government of Nepal has established a National Agriculture Genetic Resources Center (NAGRC) or National Gene Bank (NGB) and more than

12000 crops are conserved by NGB. NAGRC also assisted to the CSBs for their capacity building and sustainability. The major duties of CSBs are conservation, registration and commercialization of local landraces but only 35 crop varieties are registered till now (SQCC, 2019). In 2003, Local Initiatives for Biodiversity, Research and Development (LI-BIRD) facilitated the establishment of a community seed bank for the first time in its history at Kachorwa village of Bara district in the Central Terai, Nepal, as a part of a global project called strengthening the scientific basis of In Situ Conservation of Agricultural Biodiversity (Shrestha & Sthapit, 2015).

Thus the main objective of this paper is to analyze the community base seed system for food and nutrition security in Nepal. This paper discusses the seed systems, CBSS and its relation to biodiversity and food & nutrition security, constraints and challenges, and suggest some policy interventions to strengthen the seed system in Nepal.

2. Situation Analysis on Seed System

2.1 Varieties with Characteristics

Nepal Agricultural Research Council (NARC), autonomous organization, has the responsibility for the varietal development for Breeder Seed (BS) and Foundation Seed (FS) production of different agricultural crops. Historically, the focus of agriculture research was in OPVs of cereals, pulses and oilseed crops. Since 1960 as of end of 2019, total 315 varieties of cereals, pulses and oilseeds have been released/ registration by National Seed Board (NSB). Out of 315 varieties, cereals consist of 255 varieties (rice-123, maize-88, wheat-32), pulses consists of 41 varieties and 19 varieties of oilseeds. Total numbers of varieties (OPVs and Hybrid) in active list are 698; among them, 48.7% are open pollinated and 51.3% hybrid varieties are released and registered. Almost all of the registered varieties are imported hybrids (Table 2). Older varieties released before the 1990s still dominate the OPVs in the field. Popular open pollinated varieties of rice are Sabitri, Makawanpur-1, Ramdhan, Sawa Mansuli, Sarju-52, Khumal-4 and Sukkha-2. Similarly, popular open pollinated maize varieties are Manakamana-3, Rampur Composite, Deuti, Arun-2, Ganesh-1 and Ganesh-2. In case of wheat, Gautam, WK 1204, Dhaulagiri, Chakhura are the popular varieties in the country (Table 2). There is not any hybrid variety used in case of wheat. Hybrid research is just started form 2013. In the case of hybrids, only seven varieties of maize (Gaurav hybrid maize, Rampur hybrid-2, Khumal hybrid

maize-2, Rampur hybrid-4, Rampur hybrid-6, Rampur hybrid-8, Rampur hybrid-10) and 1 variety in tomato (Srijana) have so far been developed in the country.

Table 2. Number of crops and varieties release and registration

Crop	Release	Registered	Total
Chaite Rice	7	-	7
Rainy Season Rice	62	54	116
Maize	27	61	88
Wheat	31	1	32
Millet	5	-	5
Barley	6	-	6
Buckwheat	1	-	1
Legumes	40	1	41
Oil crops	17	2	19
Industrial crops	12	0	12
Potato	11	2	13
Vegetables (36)	39	298	337
Forage crops	15	2	17
Fruit crops	2	2	4
Total	275	423	698

Source: SQCC (2019)

2.2 Seed Production

Breeder and foundation seed is mainly produced by National Agricultural Research Council (NARC). Additionally, the Foundation Seed is produced by NARC, National Seed Company (NSC) and 43 registered authorized Private Seed Companies (PSC). Certified and improved/ labeled seeds are produced by National Seed Company Limited (NSCL), Salt Trading Corporation (STC), and seed production programs supported under DISSPRO, CBSP and CSB. Major crop seed productions in FY 2016/17 are given in Table 3.

Table 3. Seed production (tonnes)

Crops	Breeder Seed	Foundation Seed	Certified Seed	Improved Seeds
Paddy	21.34	441.42	258.11	10297
Maize	4.9	75.82	9	2989
Wheat	49.37	440.19	247.06	13983
Lentil	1.1	9.37	0	398
Rapeseed	0.23	10.25	0	183

Source: SQCC (2017)

2.3 Seed Replacement Rate of Major Crops

The Seed Replacement Rate **(**SRR) of different crops has been estimated to be rice 18.42%, maize 15.44%, wheat 15.22%, lentil 8.6%, rapeseed 12.19% and vegetable 75% (Table 4). There are several reasons for being low levels of SRR in cereals and vegetables includes high cost of improved seeds, huge storage losses, inefficient conversion of breeder seeds to certified seeds, less engagement of private sectors, lack of awareness about potential of quality seeds, unavailability of quality seeds. The major attributing factors of using higher extent of local seeds are: home saved/ self-retained seeds, less replacement frequency, poor distribution mechanism, and non-availability of quality seeds. The SRR is mostly contributed by hybrid seeds, particularly in maize, rice and vegetables. Hybrids seeds of rice and maize are mostly cultivated in Terai region of the country. The OPVs are mostly grown in hill but the farmers are constrained to get the OPVs seeds.

Table 4. Seed Replacement Rate (%)

Year	Rice	Maize	Wheat	Lentil	Rapeseed
2007/08	5.83	4.55	6.52	-	-
2008/09	6.51	4.75	8.40	-	-
2009/10	9.10	5.23	9.39	-	-
2010/11	9.89	9.89	9.89	-	-
2011/12	10.40	11.30	10.40	-	-
2012/13	11.90	11.40	11.30	-	-
2013/14	13.40	11.00	11.30	4.10	7.10
2014/15	13.50	13.00	13.40	4.30	7.70
2015/16	13.90	13.50	14.00	4.50	8.00
2016/17	14.50	15.30	15.10	4.80	8.60
2017/18	18.42	15.44	15.22	8.60	12.19

Source: SQCC (2019)

2.4 Institutions for Seeds Production, Marketing and Regulation

National Seed Board (NSB) under Ministry of Agriculture and Livestock Development (MOALD) has been constituted to implement *Seed Act, 2045* (BS) and advice government in all matters concerning the development of a viable seed industry in the country. The NSB has introduced an elaborate set of quality standards for various types of seeds. Seed Quality Control Centre (SQCC) is mandated to monitor these standards in all seeds produced in the country. Under the existing Amendment *Seed Act 2008*, two systems for quality control are provided i.e. certification and truthful labeling with minimum standards. Certification service is provided by the Central Laboratory (CL) and the Provincial Laboratories (PLs). The Nepal NARC, the specialized government agency responsible for production of Breeder Seed (BS) and Foundation Seed (FS) in Nepal.

The National Input Company Ltd. (NICL) is a subsidized public company under MOALD is engaged in seed production, processing and marketing of different crops. Cereal seed business is mostly carried out by public sector like NICL and Salt Trading Corporation (STC) in the country. These public organizations distribute seeds across the country through their dealer's network. Furthermore, there are about 40 registered seed companies and more than 4000 agro-vets in the private sector handling both hybrid and OPV seeds. In addition, some 100 seed cooperatives and more than 1,000 CBSP groups, mostly in the hills, are involved in seed production and marketing of OPVs. The community-based organizations (groups, cooperatives, companies) together with the public and private sectors are important institutions in the seed system. These organizations provide the necessary foundation for a fast growing, competitive and sustainable seed sector within the country.

The different projects with the assistance of various donor agencies launched under Ministry of Agriculture and Livestock Development/ Department of Agriculture (DoA) in the country. The major objectives of the projects are to make food security to the growing population through increasing production and productivity of food crops. For this, these projects support on seed production, processing and marketing of major food crops. The major focus of these projects is to help farmers' groups, cooperatives and companies in profitable market-oriented production and improve access to markets through value chain. The names of the projects are Project for Agricultural Commercialization and Trade (PACT), Integrated Water

Resources Management Project (IWRMP), Kisankalagi Unnat Biu-Bijan Karyakram (KUBK), Agriculture and Food Security Project (AFSP), Raising Income for Small and Medium Farmers Project (RISMFP).

3. Seed Demand and Supply

3.1 Seed Demand

Estimated seeds demand of rice, wheat, maize, lentil and rapeseed-mustard from 2012/13 to 2017/18 in Nepal is presented in Table 5. This shows that demand of rice, maize, lentil, rapeseed-mustard seeds are found to be in increasing trend, while wheat seed was in decreasing trend. Recently, digital seed balance sheet system is initiated by SQCC. Those who are willing to get seeds from related organization can simply fill up the form "'Consumer Registration", the entire authorized seed supplier will get user ID and password. The suppliers put the quantity of seeds, which they are produced. The registered consumer will get seed, which is managed by the SQCC.

Table 5: Demand of major crops seeds in Nepal (tonnes)

Crop	2012/13	2013/14	2014/15	2016/17	2017/18
Rice *(Oryza sativa)*	76,576	71,029	67,904	71,195	73,477
Wheat *(Triticum aestivum)*	91,833	90,509	89,100	92,703	84,821
Maize *(Zea mays)*	21,785	21,241	21,500	19,552	23,853
Lentil *(Lense culinaries)*	6,829	6,829	6,890	9,652	
Rapeseed-mustard *(Brassica compestris var toria)*	1,985	1,985	1,985	2,113	
Vegetables	NA	NA	NA	NA	2,868

Source: SQCC (2018)

Note: NA is Not Available

3.2 Seed Supply

In general, it is estimated that more than 80% of the total seed demand is met by informal sector i.e. farmers are producing and preserving their own seeds and it is utilized for planting in the next season. Farmer to farmer exchange also takes place in case of utilization of these seeds. Similarly, formal seed sector contributes only 16 to 17% of the total demand of seeds in Nepal. The trend of improved seeds supply (i.e. from formal sector) of major crops is presented in the Table 6. It is observed that demand and supply of improved seeds are more in 2016/17 than the previous year.

Table 6. Supply of major crops seed in Nepal (tonnes

Crop	2012/13	2013/14	2014/15	2016/17
Rice (*Oriza sativa*)	9,135	9,537	9,117	10,297
Wheat (*Triticum aestivum*)	10,958	10,216	10,210	13,983
Maize (*Zea mays*)	2,492	2,330	2,520	2,989
Lentil (*Lense culinaries*)	190	280	290	495
Rapeseed-mustard (*Brassica compestris var toria*)	154	140	140	183

Source: SQCC (2017)

3.3 Seed Balance

Basically breeder seeds are produced by Nepal Agriculture Research Centres under the close supervision of scientists. The stock of breeder and basic or source seeds is in research centers and other seed producing groups, cooperatives, companies and community seed banks. This indicates that seed production is decreasing as compared to previous years. As a result, seed traders are more attracted to import hybrids and open pollinated varieties. Similarly, basic seeds are produced by NARC and private seed companies, groups, cooperatives and institutions. Seed balance sheet and stock amount of seeds of open pollinated varieties are given in Table 7.

Table 7. Seed balance sheet of open pollinated varieties in 2018/19

Crop	Production (tonnes)		Demand (tonnes)		Stock (tonnes)	
	Breeder Seed	Basic or Source Seed	Breeder Seed	Basic or Source Seed	Breeder Seed	Basic or Source Seed
Rice	30	476.87	17	135.6	13	341.27
Maize	5.5	78.99	2.33	23.26	3.17	55.73
Wheat	65.5	485	39.5	173.3	26	311.7
Lentil	1.15	8.7	1.2	4.8	-0.05	3.9
Rapeseed and mustard	0.8	10.5	0.79	4.1	0.01	6.4

Source: SQCC (2019)

3.4 Seed Export and Import

3.4.1 Seed Import

The global trend has witnessed the shift of farmers' choice from OPVs to hybrid varieties. In case of Nepal, adoption of hybrid seed is higher in *Terai* as compared to other belt. Nepal imports large quantity of rice and maize seeds and its trend is increasing every year. It is estimated that, more than 90% of these imported seeds are hybrid. Most of the hybrid seeds are imported from neighboring countries (for example, India and China). There is significant involvement of private sectors, especially in the import and distribution of hybrid seeds. The status of major crop seeds imported is given in the Table 8. Hybrid seeds of rice and maize mostly come from India, while small quantity of hybrid seeds of rapeseed import from China. The long and porous border between Nepal and India allows free and informal flow of both OPV and hybrid seeds from different channels, which have not recorded officially.

Table 8. Import trend of seeds in different fiscal year (Quantity in tonnes and Worth value in US$ million in parenthesis)

Crop	FY 2014/15	FY 2015/16	FY 2016/17	FY 2017/18	FY 2018/19
Rice	1,120.02 (3.456)	1,546.71 (5.596)	1,823.96 (5.78)	1,827.24 (4.34)	1,858.68 (5.41)
Maize	1,519.34 (3.43)	902.56 (2.42)	1,340.56 (3.53)	995.89 (1.8)	1,178 (3.54)
Vegetable crops	103.34 (2.43)	268.59 (4.12)	101.7 (3.57)	131.35 (1.87)	160 (3.27)
Oil seed crops	0.54 (0.49)	1 (0.98)	-	1.19 (1.56)	1.118 (1.57)
Total in million (US$)	9.806	13.116	12.88	9.57	13.79

Source: SQCC (2019)

3.4.2 Seed Export

Some of the crop seeds like Radha-4, Ramdhan of rice exports to the India from porous border, especially from Nepalganj, Bhairahawa and Krishnanagar check points. Similarly, the variety NL-297, Gautam, WK1204 of wheat is massively export to India, but has not been recorded officially. This informal export scenario has been noticed since 5-10 years back.

4. CBSS Contribution to Agriculture, Biodiversity and Food System

Improved seed varieties increase the technical, allocative and economic efficiency in agriculture that potentially play an important role in overcoming the poverty and food insecurity for the smallholder poor farmers (Shrestha et al., 2016). Furthermore, improved seed varies should have stress (biotic and abiotic) tolerance, disease pest resistance and high yielding nature that could promote the agro-biodiversity and improve the food security (Shrestha, 2019). For this purpose, traditional local seed varieties are crucial to develop new varieties having such unique characteristics. The scientific competence of South Asia's agricultural R&D agencies is high, particularly in India, but as in many developing regions of the world, stronger linkages are needed to connect agricultural research agencies and their staff with the end users of their research to improve the relevance, effectiveness, and efficiency of research outputs (Stads, 2020). Shrestha & Thapa (2020) suggested that an integrated approach of different policy options inter alia, increasing investment in agricultural R&D, promotion of private sector engagement, policy harmonization on regional trade of agricultural inputs and products, and policy harmonization on material transfer agreement could have synergetic impacts on improving food and nutrition security.

Overall, some 80-90% of seed used by smallholder farmers in developing countries is sourced from informal farmers' seed systems (Louwaars, 2007). Reliability and availability of seeds in the right time and at the right price through community based institutions is much feasible. Locally produced seeds have resilience capacity to biotic and abiotic stresses and easily adapted in adverse climatic condition that could contributes improve food security (Lopez Noriega, 2016). Poor household are often not capable to save seeds for the next planting season since their crop production is often below the subsistence level. So that CBSPs are the important source of local as well as improved seeds to the resource poor farmers who have no seed saved for subsequent planting season. On farm seed systems are essential for improving food security for developing countries. Further, in response to climate variation, stress-tolerant varieties or clusters of diverse varieties are promoted as 'good practice' to enhance system resilience. Hence, seed is a vehicle linked to promoting productivity, nutrition and resilience to the smallholders.

Community seed banks are repositories of local genetic diversity adapted to prevailing climatic conditions, including biotic stresses. They are useful to contribute to community-based strategies for adaptation to climate change. CBSS are enhanced or revived through traditional social seed networks that have existed for decades or centuries based on combinations of seed saving, seed exchanges, seed giving, seed bartering, and seed purchase. Due to the lack of water, the majority of farmers used to grow Sarju-52, a rice variety released almost 30 years ago, this is very susceptible to bacterial leaf blight. Among the rice varieties; Sukkha-2, Sukkha-3 and Kachorwa-4 are becoming popular having ability to tolerate drought and require less water compared to other varieties.

Farmers' seed system is vital for food and nutrition security. Farmers' seed systems are those in which farmers produce, select, save, re-use and acquire seeds, which is out of the official or large scale commercial channels. Reliability and availability of seeds at the right time and in the right price, as well as easy access, are crucial for smallholder poor farmers but such hallmarks might not be universal in all systems. Farmer' seed systems are often considered good traditional practices for seed security and therefore, for ensuring food sovereignty. Studies have indicated that depending upon crops and countries over 60 to 85% of the seeds of the main staple crops come through informal sectors in developing countries (Tripp, 1998; Louwaars, 2013) and 99% in the case of neglected and underutilized crop species (Sthapit et al., 2010). Such informal seed systems play a central role in the provision of planting materials in developing countries and are important for maintenance, adaptation and exchange of crop genetic resources in the landscape. Popularizing and institutionalizing 'truthfully labelled' seeds as flexible means of promoting seed trade in the rural areas by informal, semi-formal and formal systems can directly contribute to strengthening food and nutritional security as well as create additional business opportunities in seed industry.

5. Challenges and Opportunities on Seed Systems

5.1 Challenges

i) Seed import is in incremental trend over the years mainly from India and China by formal, semi-formal and informal channels. The major issue of increasing seed import is disappearing and losses of local landraces preserved by farmers in their own fields. Due to porous

border and weak quality control systems, a large volume of seeds have been imported from India each year that reduce the productivity in agriculture and eventually affects the food security of the people. Unclear and undefined revenue policy enforced to import seeds through illegal practices.

ii) The majority of the seed producer groups, cooperatives, companies and agro-vets are concentrated more in Terai regions, while lacking in the hills and high hill areas. Thus, all the concerned stakeholders are encouraged to engage in the hill and high hill areas towards the smallholder farmers.

iii) Less seed cycling—majority of the certified and improved seeds are used as food that exerted to reduce the use of improved seeds by farmers.

iv) Local seed business is less profitable as compared to other business; so the most of the farmers and companies are not willing to engage in seed business.

v) Field certification, tagging and seed certification are problematic phenomenon due to unavailability of lab, and technical & authorized technical manpower.

vi) Farmers are frequently encountered by price variation of same hybrid crop seed varieties. Thus, the government should be taking care to control the market failure on unlimited and unpredicted price changes of seed varieties that could help smallholder farmers to avail improved seeds affordable and accessible.

vii) Lack of investment in research and development from public and private sector, and lack of professionals/ trained manpower faced by the seed industry.

viii) Lack of availability of source seed of preferred varieties of major crops, together with the higher costs involved in seed and its transportation are constraints in the seed industry.

ix) Weak value chain development of seeds including seed processing, storage, packaging and brandings facilities encountered in the seed industry.

x) Conservation and registration of local landraces can do easily but its commercialization and trade is very challenging.

The community gene/ seed banks can be important forms of local collective action contributing both to sustainable agriculture and the conservation of agro biodiversity. A strong sense of community ownership and belongingness is an important factor of viability. Regular exchanges of seeds and gaining knowledge are the beating heart of community seed banks. An enabling policy environment can legitimize community gene/ seed banks and provide a stimulus to grow. There are most likely other socio-economic, environmental, and political factors in the CBSS in Nepal. We foresee that CSBs will survive if they can provide the seeds that are needed and demanded, and if they can be operated as commercially viable enterprises. As a community owned and managed activity, with integrated activities consisting of local financial resource mobilization, creation of conservation fund, and associated income generation activities, the CSBs would be effective and sustainable.

5.2 Opportunities

i) Nepalese seed industry is undergoing wide range of transformations with increased role of private sector in research, production, marketing and trade of seeds.

ii) Diverse climatic condition from tropical to sub-tropical and temperate regions favors for varieties of seed production in the country. Specifically, here is more possibility for collection, conservation and use of traditional underutilized crops for developing improved varieties and they are also climate resilient and nutrient dense.

iii) The CBSS is imperative for the smallholder farmers to produce seeds, collect, save, transform and use for the next season in a collective way that contribute to the biodiversity conservation and improving food & nutrition security of the resource poor farmers.

iv) Sustaining mechanism using a large portion of the budget as a seed revolving fund can be an important factor for sustainability of seed production and distribution activities. Seed quality control (through truthful labelling) and linkage with the markets are imperative for sustainability of seeds available to the farmers.

v) Increasing demand for food diversity, development of hybrid seed varieties, accredited seed testing laboratory, diversified agro climatic zone, increasing awareness of farmers, growing number of seed traders, strong government policy.

vi) The seed producers are well trained in technical aspects of crop husbandry, seed production and management and the groups have developed its own identity in seed production and management (tagging, bagging with logo). The local governments with agriculture technicians, Agriculture Knowledge Centre (AKC), Provincial Seed Labs, Provincial Ministry of Agriculture, Seed Quality Control Centre, Private seed companies, Community Seed Banks and private sectors (PDP) could constantly contribute to the seed sector.

6. Policies and Regulatory Framework in Seed Sector

Nepal's advantage in seed sector development includes favorable policy and regulatory environment. Nepal has formulated *Agriculture Development Strategy (ADS) 2014* (MOAD, 2014) is a long-term policy document to guide the agriculture sector for the next 20 years (2015-2035). It has clearly emphasized on effective implementation of *National Seed Vision (2013-2025)* through sufficient investment and capacity building. The 14th *Three Year Interim Plan (TYIP) 2016/17 to 2019/2020* gives priority to produce good quality seeds by strengthening government-owned and private farms, which produce certified and improved seed. Seed regulatory framework include the laws, regulations, norms and standard practices that guide and determine variety release, seed certification and seed distribution. The *Seed Act 1988 (amendment in 2008), National Seed Policy 1999, Seed Rules 2013, and National Seed Vision (2013-2025)* support the seed sector development in the country. The seed storage capacity is estimated to be about 11,000 tonnes (8,700 tonnes with NSCL and 2,300 tonnes with private and public agencies) (SQCC, 2013). There are 20 processing plants operational at present in both public and private sector. Altogether, there are 17 seed testing laboratories established in different parts of the country, out of which, 13 are functional and two are owned by the private sector. Seed Act amendment 2020 has been tabled at the Parliament. Licensing of tissue culture labs (potato, citrus, and banana) has been initiated. Potato and vegetable seeds certification process has been started. Digital Enabled Seed System mechanism has been implemented. Authority provided to 7 Provincial governments for assignment of Crop Inspectors for each province. The strengthening of seed production and its distribution has emerged as one of the most important priority area of the country. The *Seed Act 1998 (2008 amendment)* and *Seed Rules 2013* have decentralized the quality control system by making provision for the establishment of private seed testing laboratory,

commercial sell of truthfully labeled seeds, and for private crop inspectors, seed samplers and seed analyst to be engaged in seed quality monitoring and testing.

The *Seed Act, 1988 (1st Amendment, 2008)* provides opportunities to the private sector for enhancement of seed production, trading and marketing. The act was effectively functioning since 2012. *The Seed Regulation, 2013* supports for the well-functioning of the act. *National Seed Policy 1999 was* working as a guideline for the variety development, seed development, quality control and marketing. A long term vision formulated in seed sector i.e. *National Seed Vision 2013-25,* which provides continuous guide to strengthen and develop the seed sector in the country. Seed directives, which have provision for certification, licensing, seed trading, and seed import and export. More than 40 seed companies/ cooperatives and groups are involved in foundation seed/ source seed production. Seed testing laboratories are established in each province and lab services are also taken from more than 10 private seed testing laboratories. Hybrid seed production has been started by both government and private sector. Furthermore, government initiated to simplify the process/ fast tracking for registration of new varieties.

7. Recommendations for Strengthening Seed Systems

The major recommendations for strengthening seed system are as following:

i) Establish Seed Research and Biotechnology Centers to develop new crop varieties that is high yielding and stress tolerance to biotic and abiotic extremes.

ii) The government should take initiatives for accessibility of foundation/ source seeds in adequate quantity to the seed producing farmers.

iii) Conducive environment need to be established for increasing diversities in crop varieties and large quantity of foundation seed production at the farmers' level.

iv) Explore and promote local/ national/ international markets for diverse crop seed varieties.

v) Create and reinforce connections among actors (research institutes, seed producers, traders, governments, etc.).

vi) Capacity building of concerned stakeholders involved in seed systems.

vii) Policies should be formulated and supported for strengthening the CBSS and local seed systems. Government should encourage to the private sectors for enhancement of the healthy seed business.

8. Conclusions

The smallholder farmers in the remote areas are frequently encountered by lack of access to improved seeds because of higher concentration of private sectors and seed suppliers in the urban areas. The community based seed production system therefore contribute to avail seeds for those farmers who lives in village areas. This challenge can be addressed in the most practical way through provincial government and local government might be focused on seed production and provisioning through small seed enterprises, CBSPs and CSBs. In fact, diverse agro-climatic regions in the country ranged from tropical to temperate and alpine provide huge opportunities to produce seeds of wide range of crop varieties. The government policies and programs should create enabling environment to exert synergetic efforts from public and private sectors for enhancing improved seeds to be efficiently available to the small-scale farmers. The community based seed system could be the best option to avail improved seeds to the smallholder farmers that helps to reduce the import of hybrid seeds, promote domestic seed companies, conserve the biodiversity and eventually improve the food and nutrition security in Nepal.

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Country Perspective Paper

Chapter 9

Strengthening Community Based Seed Systems for Improving Food and Nutritional Security in Pakistan

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Abstract

Agriculture sector is the main source of national economy. However, with increasing population and decreasing natural resources (land and water), the impacts on hunger, malnutrition and poverty is severe. The effects of climate change further heighten the potential dangers to food and nutritional security. In order to make agriculture sector more competitive and profitable through enhancing productivity on sustainable basis, seed is the basic input and has an imperative role. This area was predominantly under public sector domain, however, with the development of regulatory and legal frameworks the role of private sector keeps on enhancing in recent years. Keeping in view that the formal seed supply (public and private sectors) system could not meet the domestic requirements and hence around 60% of the seed demand is met through informal seed system. Community based seed system (CBSS), though informal, is one of the powerful tools to enhance seed supply and meet the local requirements. CBSS has demonstrated successful interventions in various countries across the globe, yet its potential is not fully utilized in the country. Although there exists a number of farmers' organizations however, their role in seed related activities needs to be recognized and regularized. Capacity building and technical & financial supports are the key to success of the CBSS. Such interventions can facilitate in fulfilling the domestic seed demands and can contribute in overall enhancement of agricultural productivity.

Keywords: CBSS, formal seed, informal seed, agricultural productivity, Pakistan

1. Background

The Islamic Republic of Pakistan, located in South Asia, is a land of great topographic and climatic contrasts. It covers 79.61 million hectares (ha) geographical area situated between latitude of 24 and 37 degree north and longitude of 62 and 75 degree east. The country is endowed with a great variation in its landscape from Indus plains to deserts, from forests to Salt range and Potohar Plateau, from the western bordering highlands to Baluchistan Plateau, from the northern high mountain ranges and snow-covered peaks to the coastal areas of the Arabian Sea in the south.

Pakistan is basically an agricultural country and its economy mainly revolves around this sector. However, over the last few decades national economy witnessed a considerable change in the composition of Gross Domestic Product (GDP) and Services and Industrial Sectors, being beneficial, grew at fast track. Though, the share of agriculture in GDP has been declining (34% in 1975), owing to being volatile and inconsistent, it still accounted for 18.5% of GDP during 2018/19. Despite its declining share it remains the single largest sector of Pakistan's economy as it stimulates other sectors by supplying raw material, having 39% jobs absorption ability and an overwhelming majority of the population in rural areas depends directly or indirectly on income streams generated by the agriculture sector.

Agriculture Sector consists of four sub-sectors, which include crops, livestock, fisheries and forestry. The crops sharing 6.50%, livestock 11.22%, fisheries 0.39% and forestry 0.39% of the total contribution of this sector towards GDP. In order to improve the food security, it is necessary to enhance domestic agricultural production through increased productivity. Average land holding, however, is very small in Pakistan (Figure 1). Farms with less than 2 ha of land constituted 64% (5.35 million) of the total private farms but they operated only 19% (4.12 million ha) of the total farm area. Whereas, the farms that were of 10 ha and above in size, comprised only 4% (0.30 million) of the total farms but they commanded 35 per cent (7.34 million ha) of the total farm area (GOP, 2012). The government of Pakistan is striving hard to make agriculture sector more competitive and profitable through higher crop production in sustainable pathway.

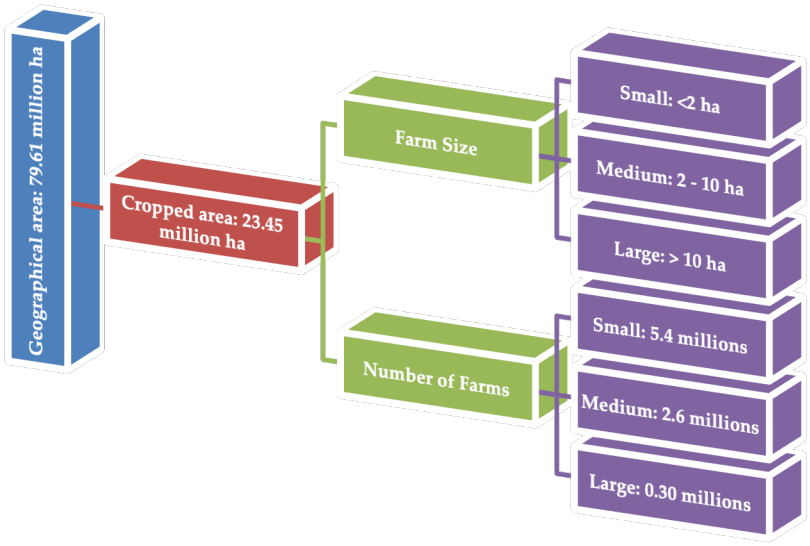

Figure 1. Land utilization statistics in Pakistan
Source: ASP (2019)

2. Situation Analysis

2.1 Area, Production and Productivity of Major Crops

The crop sub-sector is further divided into two categories: major/ important crops (wheat, cotton, sugarcane, rice, maize) and minor/other crops (pulses, other cereals, oilsseeds and horticultural crops). The five important crops account for 22% to the value added in overall agriculture and 4.06% in GDP. The other crops account for 11.2% of the value added in overall agriculture and 2.08% in GDP.

There are two principal cropping seasons in Pakistan. The summer, which is locally called as *Kharif* season starting from June and extended until September, and other as winter, locally known as *Rabi* season, the duration of which is from October to May. Rice, sugarcane, cotton, maize, mong, mash, bajra (millet) and jowar (sorghum) are primary “Kharif" crops while wheat, gram (chickpea), lentil (masoor), tobacco, rapeseed, barley and mustard are major "Rabi" crops.

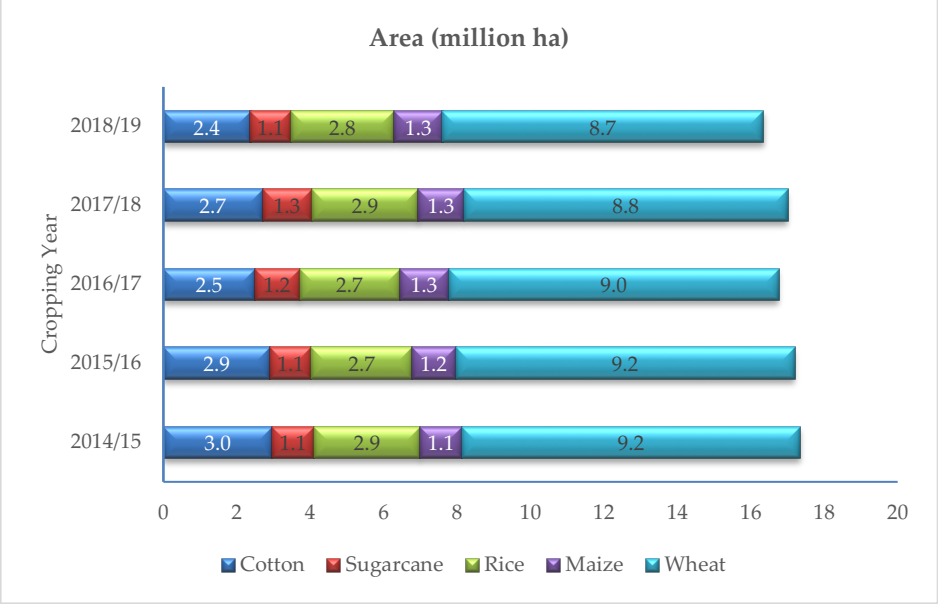

Figure 2. Area occupied by important crops in Pakistan during last five years

Source: MoF (2019)

Cotton is considered as life line of Pakistan's economy. It faces significant challenges vis-à-vis competing crops especially sugarcane. This leads to slight decline in its area. However, among the major threats to its production is the attack of various insects/ pests. Sugarcane, on the other hand, is a high value cash crop, while rice is also an important food as well as cash crop in Pakistan. Wheat, being the staple diet, is the most important food crop and cultivated on the largest acreages and almost in every part of the country (Figures 2-4). After wheat and rice, maize is the third important cereal crop. The increased production and productivity of maize, in recent years, is attributed by the availability of improved seeds. Contrary to this, low economic returns, periodic disposal problems and various emerging and re-emerging biotic and abiotic threats are the major challenges that hamper outputs of other crops (MoF, 2019). For instance, varying cotton yield is due to the unfavorable weather conditions prevailed during the cropping season, coupled with various biotic threats like whitefly, pink bollworm and other pests/ insects. Likewise, yield fluctuations of sugarcane are indicative of low economic return and disposal problems faced by the growers (Figure 4).

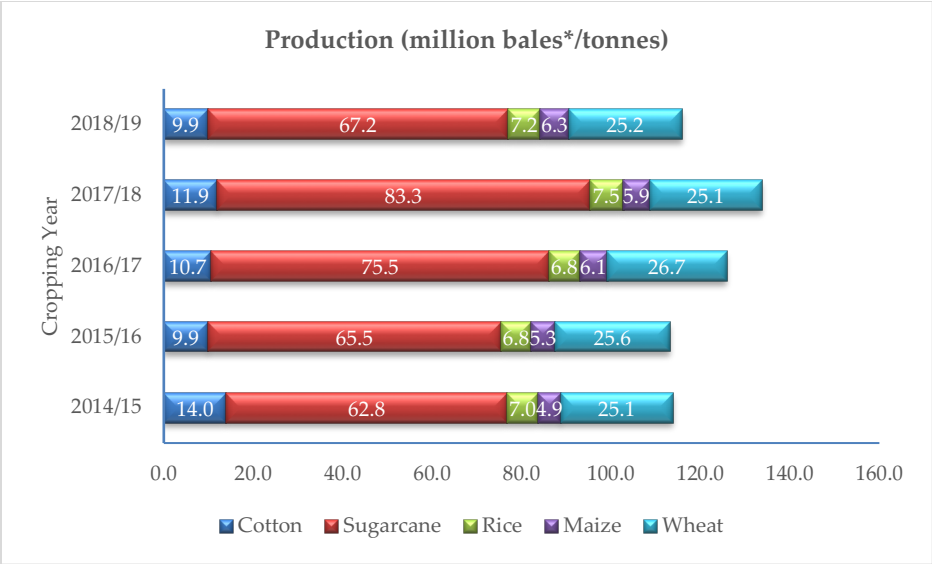

Figure 3. Production of important crops in Pakistan. Source: MoF (2019)

Note: * Cotton production in bales, others in tonnes

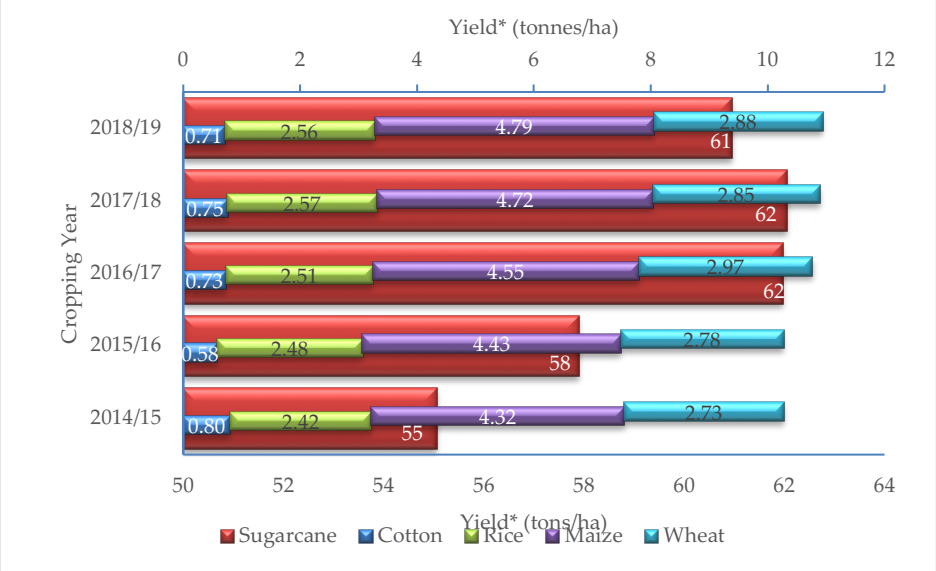

Figure 4. Productivity trend of important crops in Pakistan. Source: MoF (2019)

Note: * Sugarcane yield depicted at primary horizontal axis while others at secondary horizontal axis.

2.2 Production of Seeds of Major Crops

Seed is the basic input for agriculture production and has an imperative role in enhancing productivity. Pakistan seed industry started its journey since 1976 with the dominance of public sector. Crop variety development, seed multiplication and distribution were carried out by the public sector. However, in mid 80s some private sector seed companies made a debut in the seed sector. Overtime with the development of private sector substantially increased its role in seed production and distribution. There has been considerable increase in the number of private sector seed companies in the country.

Federal Seed Certification & Registration Department (FSC&RD) under the Ministry of National Food Security & Research provides seed certification services and has mandate for field crop inspection and seed testing, registration & certification of seed & plant material in the country. The seed standards adopted for various seed classes in Pakistan are summarized in Table 1.

Table 1. Seed quality standards for various classes

Standards	**Seed Classes**				
	Pre-Basic	**Basic**	**Certified**	**Approved**	**Truthfully Labeled**
Field Standards (OPVs)					
Rotation (min. Years)	1	1	1	-	-
Isolation (min. meters)	10	10	3	-	-
Other varieties (max. %)	None	0.05	0.2	1	
Other species (max. %)	None	None	0.05	0.1	
Objectionable weed plants (max %)	None	None	0.02	0.05	
Infected plants (max. %)	None	None	0.2	-	-
Seed Standards					
Pure seed (min. %)	99.99	98	98	97	97
Other distinguishable varieties (max. %)	None	0.05	0.2	1	
Other crop seeds (max. %)	None	None	0.05	0.2	0.1
Objectionable weed seeds (max. No./kg)	None	None	5	15	0.05
Inert matter (max. %)	0.01	2	2	2	2
Infected seeds (max. %)					
Germination (min. %)	85	85	85	85	75
Moisture content (max. %)	12	12	12	12	-

Source: ICARDA (2002)

The seed supply system in Pakistan is categorized as *Formal System* and *Informal System*. The quantity of seed mentioned in Table 1, indicates the Formal System wherein the public sector research institutes are involved in developing varieties as well as their pre-basic and basic seed. The three provincial seed corporations are playing pivotal role for supplying basic and certified seeds in public sector. However, national level seed companies (currently 521 active companies), five active multi-national seed companies (Bayer Crop Science Pakistan Ltd., ICI Pakistan Ltd., Monsanto Pakistan Agri. Tech. Ltd., Pioneer Pakistan Seeds Ltd. and Sygenta Pakistan Seeds Ltd.) and seed importers supply the bulk quantity of certified seeds in the country.

Table 2. Seed requirement and availability in Pakistan

Crop	Total Seed Requirement (000 tonnes)	Seed Availability (000 tonnes)			
		Public	Private	Imported	Total
Wheat	1,073.352	42.934	386.407	-	429.341
Cotton	63.232	1.197	55.783	-	56.980
Paddy	41.385	4.312	52.601	2.756	59.669
Maize	28.892	0.237	1.222	12.776	14.235
Pulses	42.674	0.010	1.391	-	1.401
Oilseeds	10.790	-	-	0.072	0.072
Vegetables	8.400	-	-	2.123	2.123
Fodders	61.140	-	-	11.659	11.659
Potato	415.000	-	-	2.397	2.397
Total	1,744.865	48.690	497.404	31.783	577.877

Source: MoF (2019)

Overall, the seed sector is growing rapidly in Pakistan, with private seed companies playing a leading role in providing certified seed. Given that, around 33% of the total seed requirement is being currently met (Table 2). Apart from paddy, and to some extent cotton, there exists a lot of scope for further growth in this sector. Owing to this, the Government of Pakistan has taken special initiative under Prime Minister's Agriculture Emergency Program (2019-24). Amongst others, this program is also focused on oilseeds and pulses with one of the key interventions of ensuring seed availability through national and multi-national seed companies. Pakistan Agricultural Research Council (PARC), an apex research organization, in addition to other public sector organizations like Pakistan Central Cotton Committee (PCCC)

and relevant institutions of Pakistan Atomic Energy Commission (PAEC) is also playing crucial role in seed related activities.

2.3 Seed Trade

Since the creation of Pakistan as an independent State in 1947, the seed sector has passed through different phases. In the first phase, the farmers basically were dependent on their own seed (*creating informal system*) as very few government research institutions existed. In the subsequent phases, with procedural and institutional development, private sector was more and more engaged in seed related business activities.

The major seed related legal framework in Pakistan consists of *Seed Act, 1976*; *Seed (Amendment) Act, 2015;* Seed (Registration) Rules, 1987; Procedures, Directions and Seed Standards, 1988; Seed (Truth-in-Labeling) Rules, 1991; Pakistan Fruit Plants Certification Rules, 1998; Seed (Business Regulation) Rules, 2016; *Plant Breeders Rights Act, 2016* and Plant Breeders' Rights Rules, 2018. Given that, Pakistan is not self-sufficient in seed production and hence imports substantial quantity of seeds (Figure 5).

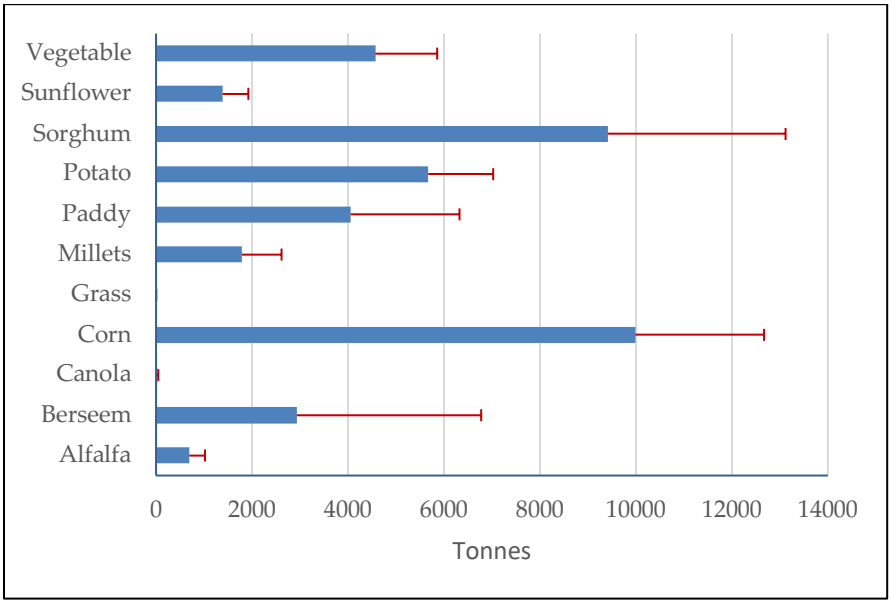

Figure 5. Crop wise seed import (average of last five years with standard deviation bars)

Source: MoF (2019)

In the circumstances, the enactment of *Seed (Amendment) Act 2015* would serve as an effective deterrence against the sale of fake and substandard

seeds. Moreover, the private sector has also been authorized to produce basic seeds as well as to establish their own accredited seed testing laboratories. The purpose is to attract more investment from private sector. This could pave the path for creating a new source of revenue.

Owing to these frameworks, private seed sector aggressively went into the business. However, major such activities were focused on crops like cotton, wheat, rice, canola, sunflower, maize, and vegetables etc. The question of quality, however, keeps on arising sporadically.

2.4 Mapping Out of CBSS

Pakistan's National Agricultural Research System (NARS) has developed improved, high yielding varieties/hybrids that are tolerant to key biotic and abiotic threats (Table 3). These varieties are well adapted to respective agro-ecologies. However, most farmers have little or no timely access to improved seed and continue to recycle exhausted seed.

Table 3. Summary of registered and released varieties in Pakistan.

Crop	Number of Varieties
Wheat	162
Barley	14
Maize	43
Rice	47
Cotton	174
Sugarcane	47
Pulses	90
Oilseeds	74
Fodders	44
Vegetables	77
Fruits	84
Flowers	03
Fiber crops	01
Total	860

Source: FSCRD (2019)

Since seed is considered as an important catalyst for the development of agriculture, the use of quality seed is the foundation for food production and a precursor to crop and food diversification. Currently the system of seed supply prevails in the country, comprises of *formal* as well as *informal* systems (Figure 5). The key stakeholders in the formal system include public sector research institutes (mostly engaged in variety development), provincial seed

corporations involved in seed multiplications (major source of certified seed in public sector), national and multi-national seed companies as well as seed importers. The farmer (generally small-scale farmer) is the key stakeholder for informal seed supply system.

Under this scenario, the community-based seed production activities have emerged as a valuable tool to enhance availability of improved seed to farmers, particularly the small-scale farmers.

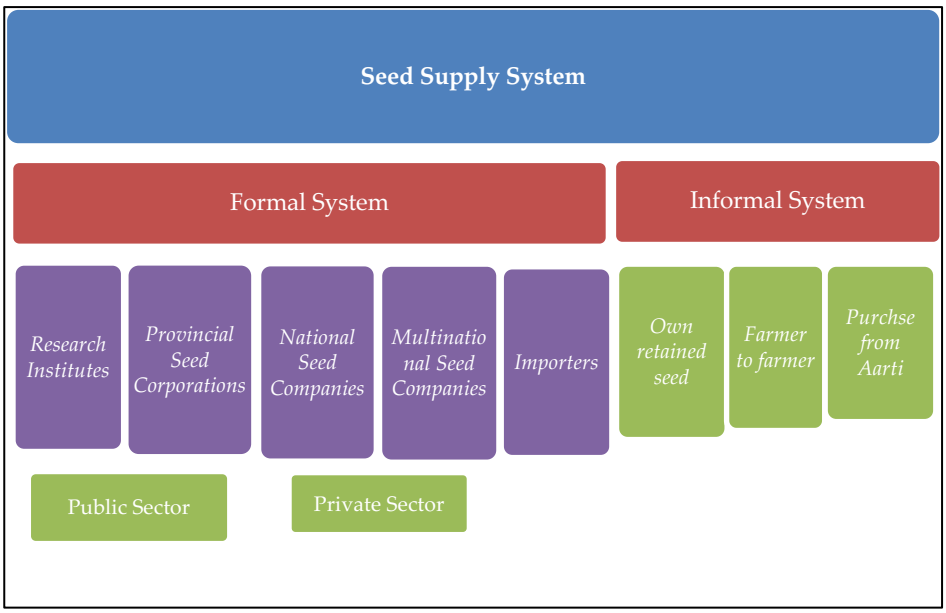

Figure 6. Prevailing sources of seed supply in Pakistan

Source: Qureshi (2019)

About 60-80 % of the seed requirements (mostly open pollinated varieties) are met through informal seed sector in various crops. There would be very large gains if the policies that permit the smooth flow of such seed to the farming communities are enacted. It is important to give due recognition to the informal sector as a low-cost source of seed till the formal seed sector is fully established to meet the domestic demands.

CBSS in Pakistan is working more efficiently in remote areas with difficult access, having narrow agro-ecological zones, and where the seed market is limited and widely marketed varieties may not be suitable. It is also successful in areas where the major crops have very high seeding rates, implying high transport costs to move large quantities of seed over considerable distances. Under such a condition, NGOs have made

substantial investments in community-based seed multiplication schemes, which are part of the informal sector.

3. Successful CBSS in Pakistan

The informal seed sector in the country is characterized by farmers' seed harvesting and processing for their own use, exchange between neighboring and related farmers, barter in the local market. These, apparently, community-based seed acquisition and distribution mechanisms constitute a seed system that prevailed predominantly in Pakistan. However, the regulatory and legal framework developed for the national formal seed system is limiting the development of this informal seed system, which subsequently adversely affected the CBSS.

Given that, though not well documented and recognized, the community-based seed system in the form described earlier, exists in the country. Various NGOs and rural community organizations are working for seed production activities at community level.

One of these is the Goth Seengar Foundation (GSF) working successfully in the province of Sindh since 1994. Since inception, GSF worked with local farmers, including farmer organizations, to enhance their capacity on seed production, seed storage etc. During the subsequent years, the scope was enhanced with the initiation of local seed bank and food security programs and resultantly claiming to reduce the market dependency of local communities.

The GSF reports that currently, 80 farmers' organizations with a combined membership of 661 women and men farmers, are working with GSF for its sustainable agriculture project. They have produced 34,680 kg of wheat production in 2017/18. Today, 529 farmers (80% of total members) are keeping their own seed and food banks. The foundation also sensitized the local farmers to grow Juwar and Bajra and ultimately mobilized and built their capacities from land preparation to harvesting.

In order to have more sustainable success in this venture by GSF or any other known or unknown organization, several other aspects have to be incorporated thoroughly. These include, among others, crop and varietal selection, source of seed, capacity building of producers for quality produce, post-harvest processing and financial assistance to resource poor farmers.

4. CBSS Contribution to Smallholder Agriculture, Climate Change Adaptation, and Food & Nutrition Security

In the contemporary crop farming, generally small holders relied mostly on farmer-led informal seed system. This system, being resilient, is successful mostly in developing countries, particularly in the wake of disasters. In a well-established CBSS, which has a variety of seed storage options, farmers are also benefitted, especially under the condition when seeds stored under one storage facility get damaged or lost.

Climate change is one of the major challenges encountered by agriculture and food system, which includes from food production to its availability, access, quality, and utilization. Moreover, extreme weather-related disasters are causing reduction in the yields of major crops and effect on nutritional security.

Increased frequency of occurrence of extreme weather events in conjunction with local and/or regional climatic variability is also accelerating loss of precious biodiversity, and resultantly, loss of seed varieties. Under such a condition, seed stored at community level could facilitate in bringing sustainability.

Such contributions are evident from the establishment and demonstrated contribution in preserving local biodiversity and sustaining crop farming in Nepal, Vietnam and some of the African countries.

Though little is known about well-established community-based interventions in Pakistan, yet it is assumed that this informal seed supply system does exist in some form particularly in marginal and stress prone ecologies like rainfed ecology and mountain areas. The apparent purpose seems to ensure food security. Since, wheat is the staple food commodity in Pakistan, the crop is being cultivated on the largest acreage (around 9 million ha) and under almost every ecology.

Given the fact that formal seed system comprising of public sector research institutes, provincial seed corporations and national/international seed companies could not fulfill the domestic seed demands, the CBSS share a large portion (around 60%) of this demand and contribute to a great deal in attaining wheat yields that make the country self-sufficient. Thus, CBSS can contribute immensely in ensuring food and nutritional security of more than 207 million people in Pakistan – the world's sixth most populous country.

5. Constraints and Challenges on CBSS Seed Value Chain

Major challenges and constraints faced by CBSS are summarized as follows:

i) The seed produced, processed and stored in a community-based seed supply system falls under the informal system and because of the reason that farmer-produced seeds are not tested for seed health and truthfulness, the assumption is made that smallholder farmers are planting poor quality seeds.

ii) The seed produced in formal system is covered by various regulatory and legal frameworks and also is heavily subsidized. Hence, the seed produced through CBSS faces a comparative disadvantage.

iii) Considering the climate change related threats and associated adaptation strategies devised by the researchers around the globe, in general, and within country in particular, the CBSS, if not technically coherent with recent advances could not be successful. Such deficiencies could hinder the selection of certain crop(s) and of particular varieties for the ecology.

iv) Lack of capacity building of various stakeholders associated with seed production, processing, storage and marketing could limit in furthering the concept of CBSS and its successful adoption

v) Lack of financial assistance restricts the process of sustaining seed related activities and ensuring quality produce.

6. Recommendations

In order the strengthen CBSS, in relation to food and nutritional security, following recommendations are being made:

i) Integration of community-based seed production activities and seed management expertise with modern seed production and processing technologies.

ii) Capacity building programs of the CBSS associated stakeholder needs to be developed.

iii) Farmer-led seed systems of the smallholder, family farming communities need to be given greater recognition and support from governments, academics and other relevant stakeholders.

iv) NGOs or farmers involved in CBSS may be registered and the crops grown for seed purpose may be certified by seed registration & certification department.

v) Set up a legal framework permitting the sale of uncertified but 'Truthfully Labelled' seed of approved varieties for enhancing crop productivity.

vi) CBSS needs to be involved in promoting value-chain driven agricultural diversification, restoration and sustainable development of agriculture in marginal areas and implementation of targeted food distribution schemes for improvement of food and nutritional security

7. Conclusions

In Pakistan, since its creation in 1947, most of the seed related activities remained under public sector domain. The subsequent developments provide ample opportunity to private sector in this area. However, both public and private sectors fall short of fulfilling the domestic seed demands in various crops and around 60% of the seed demand, still, is satisfied through informal system. Major mechanisms in this informal system comprised of retaining farmers' own seed, seed distribution from farmer to farmer and purchase from local market. Hence, there is a need to strengthen this informal system through more recognition, support in strengthening capacities and outreach, and regularization.

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Country Perspective Paper

Chapter 10

Strengthening Community Based Seed Systems for Improving Food and Nutrition Security in Sri Lanka

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Abstract

Agriculture sector is in a declining trend over decades and contributes 8% of the GDP in 2018. About 70% of the people still live in rural areas and mainly depend on agriculture. This sector encountered a number of challenges including lower production and productivity, lack of quality seeds, depleting land quality, increased cost of production, labour scarcity, less mechanization, weak value chain development, climatic resilience, and declining youth engagement in agriculture. Seed sovereignty is considered as an integral part of food system, while the Seed Replacement Rate (SRR) is low in the food crops. Community Based Seed System (CBSS) has invaluable contribution for the seed security and food security in the country. Lack of financial resources, storage, processing facilities and knowledge on seed production technology are the major constrains faced by the CBSS. CBSS are effective platforms for local collective action and empowerment in terms of the conservation and sustainable use of plant genetic resources for food and agriculture sector. Awareness creation, credit support systems and regulatory framework on the importance and support in the improvement of the CBSS can strongly promote CBSS to farming communities. Promotion of CBSS are aligned with self-sufficiency in rice, vegetables and other food crops. The CBSS plays paramount role for timely availability of seeds that is climate resilient and eventually contribute for food and nutrition security in Sri Lanka.

Keywords: CBSS, seed value chain, biodiversity, seed security, food security

1. Background

Sri Lanka is an island with a land area of 65,525 km^2 and located between 5^0 54′ and 9^0 52′ North latitude and 79^0 39′ and 81^0 53′East longitude. The island has a maximum length of about 435 km and maximum width is nearly 225 km. Climatic diversity in the country determines the bimodal pattern of monsoonal rainfall. There are two cropping seasons in the country i.e. *Maha* and *Yala. Maha* is the main cropping season, which is determined by the North East monsoon that brings rain from October to March. *Yala* is the minor cropping season prevails from April to September in South West monsoon which is predominantly limited to the Wet Zone of the country.

Agro-climatologically the island has been divided into Wet, Intermediate and Dry Zones. The Wet Zone receives relatively a higher annual rainfall over 2,500 mm, while the Dry Zone receives less than 1,750 mm and Intermediate Zone rain fall is between 1,750 mm to 2,500 mm, respectively. The Wet and Intermediate Zones are further subdivided into low, mid and up country based on the altitude as low temperature is an important climatic factor determining crop growth. Low land is demarcated as the land below 300 m in elevation and the mid land lies between 300 m - 900 m in elevation and up land above 900 m in elevation. These agro-climatic zones have further been divided in to 46 Agro-Ecological Regions based on rainfall regime, terrain characteristics, predominant soil types, land use and vegetation. Soils belonging to 14 great soil groups have been identified within the country. Among these, Reddish Brown Earths, Red Yellow Podsolic soils and the Low Humic Gley soils are the most abundant.

The country's main economic activities are tourism, tea export, textile industry, rice production and other agricultural related primary production. In addition to these economic sectors, overseas employment, especially in the Middle East, contributes substantially in foreign exchange earnings. In 2018, the service sector comprises 62% of the GDP, industrial sector 29%, and agriculture sector 8% (CBSL, 2018).

This paper mainly highlights the seeds and agricultural production situation, constraints and challenges in CBSS, and some major policy interventions to strengthen CBSS in Sri Lanka.

2. Situation Analysis

2.1 Area, Production and Productivity of Major Crops

The major agricultural food crops grown in Sri Lanka are paddy, maize, legumes, oil crops, condiments, vegetables and fruits. Rice, coconut and grains largely for domestic consumption, while tea and rubber industries are mainly focused for export purpose. The contribution of agriculture sector to GDP was dropped from 8.5% in 2010 to 7.7% in 2017 due to adverse weather conditions (CBSL, 2018).

Economically active population in agriculture sector and related fields is estimated to be 44%. More than 70% of the people still living in rural areas and their main source of livelihoods is agriculture. Agriculture is the mainstay of the rural economy that employs about 26% of total employed population in the country. About 60% of total agricultural production is directly rain-fed and tied down with the vagaries of climatic conditions mainly floods and drought. Apart from natural hazards, agriculture has become non-profitable due to low productivity and high cost of production. As a result, youth in the rural areas migrates to the urban areas seeking for better opportunities including employment and living standards. Hence, it is important that agriculture be made more attractive and prestigious through making agriculture as a better source of income generation. The uses of novel technology in agriculture is highly emphasized (SLCARP, 2018).

The agricultural land comprises 54% of the total land in Sri Lanka (3.5 million ha) consisting of home garden 41% and paddy 26% (Table 1). Coconut, tea and rubber together account for 21% of land use. The remainder (12%) is accounted for all other crops; other field crops, horticultural crops and other export crops.

Table 1. Area, production and productivity of agricultural crops (2018)

Crop	Area (ha)	Production (tonnes)	Yield (tonnes/ha)
Paddy	1,040,900	3,929,800	3.78
Maize	70,895	270,041	3.81
Green gram	8,615	9,856	1.14
Soya bean	1,510	2,500	1.66
Chilli	13,553	79,000	5.83
Cowpea	11,180	11,180	1.00
Black gram	12,976	11,852	0.91
Finger millet	6,770	8,060	1.19
Red onion	4,044	61,073	15.10
Big onion	1,448	28,047	19.37
Ground nut	15,752	27,602	1.75
Gingerly	11,872	8,589	0.72

Source: DOA (2018)

2.2 Seed Production of Major Food Crops

Government farms produce breeder seeds and basic seeds of paddy, other field crops and vegetables. Commercial seeds are produced by government farms, private sector and community-based organizations. Seed production and trade is regulated by the government/ public sector through the Seed Act No. 22 of 2003. Paddy and many Other Field Crops (OFC) are almost self-sufficient for seed production in the country. However, seeds of maize, chilli and vegetables depend on exotic hybrid seeds. Paddy seed requirement is fulfilled by the community based/ self-seed production. Community based seed production has a significant contribution in the other field crops.

In Sri Lanka, the development of crop varieties have been largely the domain of the Department of Agriculture and the commodity based research institutes. Recently, the private sector has been emerging as a contributor to variety development. The public sector involves in plant breeding and varietal development, recommendation of improved varieties, purity maintenance, basic & certified seed production of the released varieties, seed quality control, maintenance of seed buffer stocks, seed promotions, and regulating & facilitating seed functions by complying with the existing seed laws. The share of the private sector in seed production, supply, marketing and distribution has grown rapidly since the late 1980s.

Seed Certification and Plant Protection Centre (SCPPC) of the Department of Agriculture (DOA) is responsible for providing important services to farmers such as quality control of seed and planting materials, evaluation of characterization and conservation of plant genetic resources of food crops and plant quarantine activities. Regulatory functions under the Plant Protection Act No. 35 of 1999, the control of Pesticide Act No. 33 of 1980 and the Seed Act No. 22 of 2003 are also regulated by the SCPPC.

The Seed Certification Service (SCS), which reports to SCPPC is responsible for seed certification at DOA level. The SCS is responsible for: Distinctness, Uniformity and Stability (DUS) testing of proposed new varieties of crop before release; certification of breeder, basic and certified seed of paddy, OFC, vegetables, potato and planting materials produced by public and private sector institutes; testing of imported seed for conformity to required standards; post control quality testing of imported and locally produced seeds; training of relevant seed personnel including growers, nursery men, seed men and officers; and conducting research on seed technology for seed development.

The SCS is responsible to implement the Seed Act. The functions of the SCS are: certify seed and planting materials grown in Sri Lanka; issuing of seals, stickers, stamps, and labels with the mark or seal of SCS; monitoring of seed production, processing, conditioning, and storage facilities; checking of registers of seed movement and identity; ensuring that certified seed are packed, sealed and labeled in the prescribed manner; sampling of locally produced and imported seeds and checks conformity with prescribed standard; implementing standards for seed certification; maintaining and publishing a list of producers and supplies of certified seed and planting materials; certifying seeds that followed approved procedure, and finally, prohibiting sales of any seed as certified seed unless adhering to the prescribed standards.

Table 2. Seed requirement in Sri Lanka

Crop	Seed Requirement (tonnes)
Paddy	134,400
Maize	2,226
Green gram	691
Soya bean	1,074
Chilli	18
Cowpea	400
Black gram	356
Finger millet	62
Red onion	11,372
Big onion	64
Ground nut	1,870
Gingerly	212

Source: DOA (2018)

2.2.1 Seed Production at the Department of Agriculture

Seeds and Planting Material Development Centre (SPMDC) of the Department of Agriculture is mandated to supply high quality seeds and planting materials to the nation by multiplying the varieties developed by research institutes. The SPMDC produces and supplies all necessary basic seeds of paddy, OFC, vegetables and potato for the seed producers in the country in addition to a direct production and supply of a considerable amount of certified seeds and certified planting materials of above categories. The SPMDC carry out production of basic seeds and certified planting material at 27 seed farms, while production of certified seeds of paddy, OFC and vegetable is done by 14 Deputy Directors of Agriculture (Seed) units scattered all over the country.

2.2.2 Paddy Seed Production

The basic seed of paddy production (Foundation and Registered classes of seed paddy) of 28 varieties is carried out in ten government seed farms across the country. The foundation seed of paddy is produced using breeder seeds supplied by Rice Research and Development Institute (RRDI) at Bathalagoda. The Registered Seed Paddy (RSP) is produced by using Foundation Seed Paddy (FSP). The Certified Seed Paddy (CSP), which is used for the production of consumption paddy is produced from RSP. In a

normal *Yala* season the cultivated extent of paddy is about 500,000 ha and in a normal *Maha* season, it is about 780,000 ha. Therefore, about 1,280,000 ha of paddy is cultivated annually. For the cultivation of this extent, the annual CSP requirement is about 131,200 tonnes and for the production of this amount of CSP, the RSP requirement is about 3,280 tonnes.

2.2.3 Production and Supply of Seeds of OFC

The SPMDC is the main single producer and supplier of OFC seeds in the country. It targets to produce and supply all necessary basic seeds (Foundation and Registered) and about 25% of the national certified seed requirement, except maize and ground nut seed requirement. Maize is mainly cultivated in the country using imported hybrid seeds and the demand for maize seeds of Open Pollinated Varieties (OPV) in Sri Lanka is less than 5% of the total requirement. The SPMDC supplies the total demand of OPV requirement and few amount of hybrid seeds. In collaboration with farmers, initiatives have taken to increase the domestic hybrid maize seed supply. Steps are being taken to increase the seed production of parental lines of hybrid maize, in order to increase hybrid maize seed production in the country. The involvement of private sector in OFC seed production is almost negligible. With the use of breeder seeds supplied by the Field Crop Research and Development Institute (FCRDI) and its sub-stations, seeds of 36 varieties of 11 OFCs are being multiplied and produced in the four different classes of seeds, namely Foundation, Registered, Certified and Commercial.

2.3 Seed Sufficiency Ratio and Seed Replacement Rate

The private sector is dominated in seed trade in Sri Lanka. However, the DOA regulates the activities by using Seed Act. The government mechanism helps to maintain the quality of seed and planting material for the farmers. Paddy and OFCs have sufficient seed production in the country. However, maize, chilli and vegetable crops' seed requirements are mainly dependent on exotic hybrid seeds.

Seed Replacement Rate (SRR) is a ratio of the annual seed supply of formal seed sector to the annual seed requirement of the relevant crop. Annual Seed Replacement Rate (SRR) is computed by using the following equation.

$$SRR_i = \frac{[\text{Annual seed supply by the formal sector in crop}i]}{[\text{Annual seed requirement of the crop}i]}$$

Seed requirements and seed replacement rates are computed by using the average annual crop extent and recommended seed rates. There was a problem of estimating annual seed requirements as average seed rates used by farmers are sometimes, substantially different from recommended seed rates. Unfortunately, the average seed rates used by farmers are not readily available for all crops, and therefore, the recommended seed rates need to be used in most occasions. Accordingly, the seed rates recommended by the DOA are generally used to compute seed requirements, and when there is evidence that these rates are different from the seed rates used by farmers, additional information on seed requirements based on seed rates used by farmers also are presented. Data on seed issued by the private sector are not visible and only data on seed imports and domestic seed production by the private sector is available. Therefore, seed replacement rates were computed considering two scenarios. In the first scenario, it was assumed that all of the seed imported and produced by the private sector are issued to farmers. In the second scenario, it was assumed that 60% of the seed imported/ produced by the private sector are issued to farmers.

Table 3. Seed sufficiency ratio and seed replacement ratio in Sri Lanka

Crop	Seed Sufficiency Ratio (SSR)	Seed Replacement Rate (SRR)
Paddy	100%	15%
Maize	15%	53%
Green gram	50%	11%
Soya bean	100%	11%
Chilli	60%	137%
Cowpea	100%	4%
Black gram	100%	9%
Finger millet	100%	10%
Red onion	100%	NA
Big onion	80%	NA
Ground nut	100%	2%
Gingerly	100%	2%

Source: DOA (2018)

Rice, the main food crop, has a very high seed requirement of which 15% is replaced by quality seed produced. The seed replacement rates are low in the OFCs except for maize in which farmers often use imported hybrid seeds.

The imported big onion seed is not quality assured. Therefore, there is a tendency for farmers to use true seed produced in Sri Lanka, although the price is high and supply is low. Red onion is generally propagated through bulbs. These bulbs are not generally quality assured by certification. However, there is no considerable deterioration of genetic purity as the crop is vegetative propagated.

Certified Seed Paddy (CSP) Production

The annual CSP requirement of the country is about 134,400 tonnes. The CSP production is mainly done by the private seed producers such as private companies, seed producers' cooperatives, farmer organizations, and individual farmers using RSP produced by the SPMDC. The formal seed paddy production is about 20% of the national requirement, while a considerable informal seed paddy production is occurred in the country using RSP and CSP.

Basic (Foundation and Registered) OFC Seed Production

The foundation seed production is in government seed farms, while the registered seed production is both in government seed farms and through the contract seed production system. About 23,404 tonnes of Foundation seeds and 123,863 tonnes of registered seeds have been produced through both the systems in the year 2018.

2.4 Community Based Seed Systems

The main objectives of the Community Based Seed System (CBSS) are assuring availability of timely, adequate and climate -resilient quality seeds to the farmers. At present, CBSS mainly produce traditional and open pollinated varieties. However, few farmer societies have involved in the hybrid seed production (e.g. chilli). It is mainly due to the higher investment and skilled technical capacity needed for hybrid seed production.

The CBSS are managed by the farming communities themselves. CBSS help the farmers meet the seed requirement in their areas, and ultimately increase their income while fulfilling quality seed requirement of the food crop sector. These community-owned seed production systems recruit new members to the village program and collect membership fees. The seed production program managed by the seed production societies has a guide line and is supervised by the Department of Agriculture. The guidelines and the supervision assure the maintenance of the quality of seeds. The income of the

society will be utilized for the benefit of the program with the concurrence of the society.

3. Successful CBSS Model

The Extension and training division of the Department of Agriculture and the provincial Department of Agriculture are implementing the community based seed production programs and Community Based Seed Villages (CBSV). This programme has been initiated utilizing the limited resources available at the DOA. Agriculture related institutions and sub units collectively contribute its share in the establishment of these villages.

The type of seed to be produced is determined considering the climate suitability and farmer demand. Provision of seeds, issuing instructions and supervision of the programme will be the responsibility of the respective institutions involved in setting up of those villages while the certification of seed is done by the DOA. If the production is in excess of the requirement, such villages are facilitated to exchange the same with other seed producing villages or sell them in the private sector. Accordingly, this programme is used as a profit earning agri-business for farmers.

Community Based Seed Production Programs

A large number of community based seed production societies are currently operating successfully in all the districts in Sri Lanka. Basically the Extension Division, Seed Certification Service and Seeds and Planting Material Development Centre of the DOA are involved in the program. Several NGOs also extended their contributions to provide some basic needs for the societies.

Initially the Extension Officers guide the farmers to identify the necessity to form a group and help them to identify the suitable crops, market opportunities, and coordinating other relevant organizations. The basic concept is that the selected farmers' groups themselves decide what crops they will grow and look for the market opportunities. There are 15 to 25 farmers in a selected group of farmers and they should be residents of the respective village and it is considered a pre-requisite to have their own cultivable land. After forming the group, the society is converted into a **Rural Seed Production Association**, which will have an Official Board, constitution, bank account. The association is also registered under the Seed Act in the Department of Agriculture. Several formal training sessions are organized on agronomy, seed production and seed certification systems. In

addition, special programs implemented by the Extension and Training Centre (ETC) are of particular concern to these Community Based Seed Production Villages (CBSPV), to explore the ability to provide necessary equipment like seed cleaning machines, packaging to regulate the quality seed production process. Extension and seed certification service officers in-charge of the area are regularly monitored to address the issues that arise after establishment of seed farms.

The membership fees, recruiting new members and the income of the society will be utilized for the benefit of the members with the concurrence of the membership. The CBSPV are managed by themselves through self-driven, which in turn benefits the farmers in the area to meet the high seed requirement and ultimately increase their income and fulfill quality seed requirement of the agriculture sector.

A large number of societies are functioning for seed paddy production and there are many societies, which are functioning successfully for other field crops and vegetables. Table 4 summarizes the number of societies registered under Seed Act and their recorded production figures (DOA, 2018).

Table 4. DOA registered community based seed production societies, 2018

Category	**No of Organizations**	**Membership**	**Production (tonnes)**
Seed paddy	177	3,099	2,022
OFCs	37	66	1.875
Vegetable seed	16	19	1.060

Source: DOA (2018)

The quantity of seeds produced by state and private sector is insufficient. Therefore, involvement of community based farmer organizations play an important role in seed production. Table 5 shows some important information on some of the successfully functioning community-based organizations. Seed production of paddy, soybean, big onion, finger millet, green gram, ground nut, bean and potato programs are implemented in Anuradhapura, Monaragala, Matale, Kandy and Nuwaraeiliya district by the support of DOA.

Table 5. Community based seed societies in few districts

Name of the Society	Location	No of Members	Started Date	Production (tonnes)	Method of Sale	DOA Involvement
Janasirigama Soya Bean Seed Society	Janasirigama, Huruluwewa,Galenbidunuwewa, Anuradhapura	45	2016	50–100/year	To DOA	Training
Maligawila Seed Paddy Production Society	Maligawila, Okkampitiya, Monaragala	17	2018	70	To DOA	Training
HarithaBoomi Other Field Crop Seed Production Society	Monaragala	22	2018	10.2	To DOA & farmers	Training
Shakthi Seed Production Society	Mailagaswewa,Galenbidunuwewa, Anuradhapura	48	2013	Big Onion 1.3, Chili 2.4	To Farmers & DOA	Subsidies for inputs & training
Sigiriya Big onion seed production Association	Magallenapansalaroad,Digampathhakibissa, Matale	25	2018	3.0	Direct sale	Subsidies for inputs & training
Digampathha Big onion seed production Association	Digampathha, kibissa, Matale	78	2016	1.20	Direct sale	Subsidies for inputs & training

Shakthi Big onion seed production Association	Pattiwela ,Galewela, Matale	35	2016	1.00	Direct sale	Subsidies for inputs & training
Eksath Farmer OgernitionUdaweragama Finger Millet	Udaweragama, Kaikawala, Matale	25	2015	3.20	To the DOA	Subsidies for inputs & training
Green Grame Seed Produses Group	Dambagolla– Kongahawela, Kandy	60	2015	20	To the DOA	Subsidies for inputs & training
Ground Nut Seed Produses Group	Akareadiya– Dewaladeniya, Kandy	40	2010	12	To the DOA	Subsidies for inputs & training
Mandaramnuwara local Bean Seeds Society	SuwadelPotha, Elamulla, Kandy	9	2015	12	To Farmers & DOA	Subsidies for inputs & training
Mathurata Local Bean Seed Society	Ampitigoda Mathurata, Kandy	15	2014	12	To Farmers & DOA	Subsidies for inputs & training
Pragathi Seed Potato Socity	KudaOyaLabukele, Nuwaraeliya	3	2014	15	To Farmers & DOA	Subsidies for inputs & training
Mahakudugala Seed Potato Society	Mahakudugala , Ragala, Nuwaraeliya	6	2019	80	To Farmers & DOA	Subsidies for inputs & training

Source: Author's Synthesis (2019)

4. CBSS Contribution to Smallholding Agriculture, Biodiversity and Food & Nutrition Security

4.1 CBSS Contribution to Smallholder Agriculture

Food Sovereignty is the Right of the people to consume adequate and preferred foods. In order to ensure the food sovereignty right, people should have or regain democratic control over the food system, rely more on local food markets with recognizing the key role of women farmers. Seed sovereignty is expressed through the locally controlled practices of using, conserving and exchanging locally adapted seeds and other planting materials, related knowledge and, where appropriate, marketing through forms of collective action. CBSS focuses on the sustenance of rural livelihoods, local cultural and ethnic food traditions through seed and food sovereignty, the practical implementation of farmers' rights and community empowerment.

The use of local varieties has increased along with the use of on-farm resources (for example, cow dung and compost) and practices (crop diversification, mixed cropping, reduced use of chemical fertilizer and no use of pesticides). More and more farmers grow local varieties of seeds and the number of farmers are gradually increasing in the seed sector. Even with limited resources, CBBS helps to improve rural small household food security and livelihood. Conservation of indigenous species of yams, vegetables, grains and traditional rice varieties depends largely on community based organizations.

4.2 CBSS Contribution to Climate Change Resilience

Climate change adversely affected the agriculture productivity and food security. Global warming resulting in increased temperatures, erratic rainfall, and leading to severe droughts and floods could pose a serious threat to food production and productivity. A strategy could be to develop and utilize genetic sources of resistance to the abiotic and biotic stresses in agriculture. Community seed production system can also provide an opportunity for interaction and integration of informal and formal seed systems for the promotion of *in-situ* and *ex-situ* linkages to back up genetic resources locally and as building blocks of crop improvement, food security and sustainable community development and improvement of rural livelihoods.

CBBS contributes the multiple benefits of crop diversification practices such as using varietal diversity in monocultures, mixing crops with non-crop vegetation, crop rotations, polycultures, agro-forestry and mixed landscapes. Benefits derived from these strategies include pest and disease reduction, increase and stability in production, and climate stress buffering. Evidence from field trials underway in various countries offers strong support for the use of intra-specific crop diversity within the production system to reduce disease incidence and risks related to climate change, improve seed saving and storage practices, with particular attention to safeguarding seeds of plants that survive under extreme weather conditions.

4.3 CBSS Contribution to Biodiversity

Community seed production system focuses on providing access and guaranteeing availability of diverse seeds and related knowledge. Community seed banks can serve as key local sources of germplasm allowing farming communities to exchange seeds in a decentralized manner through social networks and organized events, such as diversity fairs and participatory seed exchanges. CBSS are semi-structured, and may depend on indigenous knowledge of plants and seeds selection, sourcing, retaining and management as well as local diffusion mechanisms. These systems play an important role in the seed security of local landraces at the household and community endowments and link to germplasm conservation, enhancement and utilization by the rural farmers.

4.4 CBSS Contribution to Food and Nutrition Security

Seed is one of the most important inputs in food crop production. Good quality seed has significant potential of increasing crop productivity and enhance food safety. CBSS focus on farmer management of local varieties, which have been selected overtime and produced under local environments. The system covers methods of local seed multiplication and diffusion. The system motivates traditional seed production, operating primarily at the local level though exchange mechanism and involving limited quantiles per transactions.

Seed security is pivotal for food and nutrition security. Farmers' seed systems are those in which farmers produce, select, save, re-use and acquire seeds, outside to the official or large scale commercial channels. Reliability and availability of seeds at the right time and in the right price, as well as easy access, are vital for poor smallholder farmers, but such hallmarks might

not be universal in all systems. Farmers' seed systems are often considered good traditional practices for seed security and therefore for ensuring food sovereignty.

5. Challenges and Opportunities on CBSS Seed Value Chain

5.1 Constraints and Challenges

The development of an enabling policy and legal environment is most likely the greatest challenge that most community seed banks face. CBSSs can provide an important testing ground for legislation and policies to protect, recognize and promote Farmers' Rights in the realm of agricultural biodiversity conservation. More broadly, such regulations would guarantee communities' rights to self-determination and sovereignty and provide incentives for them to continue their farming activities sustainably to the benefit of all of society. The major constraints and challenges encountered are listed below by the community based seed producing farmers.

i) Limited resources for seed production programs: Rural smallholder famers have limited resources such as land, labour and capital for investment. Seed production, processing and storage involve risk. Some of the processes need more equipment, space and time. The lack of investment ability of rural dwellers limits production quantity and quality of community seed.

ii) Lack of technology and experience on seed production: It limits production quantity as well as quality of seed.

iii) Need more commitment for seed production: Farmers have limited labour for farming. If farmer produces seeds, that needs more commitment than the production for food consumption. Therefore, many of the famers are willing to purchase seeds without participating in these programs.

iv) Weak assured market for seed production: There is a limited market for the local or OPV varieties that hindered farmers to enhance seed production under CBSS.

v) Higher production cost and risk: Compared to the food crop production, the process of seed production needs more investment. There is higher risk of damage by pest and disease as well as in storage. However, there is no proper insurance scheme for seed producing farmers.

vi) Poor seed production infrastructure: Absence of adequate and proper storage, processing, and transport facilities for community seed producing farmers.

vii) Deteriorated purity of seeds: Poor processing and handling lead to inclusion of inert material and mix with other seeds resulting to low purity of the community based seeds produced.

5.2 Opportunities

CBSS can be effective platforms for local collective action and empowerment in terms of the conservation and sustainable use of plant genetic resources and increased crop biodiversity for food and agriculture. It contributes not only to the conservation and continued use of major crops, but also to the preservation of a number of under-used species usually not targeted by formal-sector conservation and plant breeding initiatives. Many ocal varieties are tolerant to adverse climatic condition, hard environmental condition, and are resistant to pests and diseases than formal seeds.

As CBSS has not been well developed and more than 80% of the smallholder farmers use such informal seeds, there is a wide scope and potentiality to promote CBSS in the developing economies, particularly in the developing world. Every step of seed value chain of the CBSS are underdeveloped and inefficient that impels attention of the researchers, policy makers and the governments to narrow down gaps and make the informal seed system more efficient and vibrant.

6. Recommendations

Based on the discussion in the earlier sections, following recommendations are derived:

i) Awareness on the importance in the seed system in the farming community should be increased. The farmers' roles in the seed system need to be strengthened, especially in widening the genetic diversity in their fields as they become involved not just in seed exchange but also in the improvement and use of their seeds. The system of free access and exchange should be further emphasized to give the farmers full rein on the local seed delivery system.

ii) With the entry of the private sector into the local seed industry, a large quantum of inferior quality seeds as well as improperly labeled seeds are now channeling into the local markets. This situation adversely

affects the farmers, genuine seed producers and consumers hindering the progress of the national seed sector development. Thus, the private sectors need to be capacitated, supported, strengthened and regulated to produce quality seeds.

iii) Both genetic and physical purity are essentially linked with quantity and quality of seeds. Hence, regulation for quality seeds and planting materials should be given higher emphasis worldwide in the recent years, to streamline seed production and to prevent fraudulent activities plaguing the seed industry.

iv) Facilitating community-devised and generated marketing and credit support systems in the seed value chain.

v) Introducing controlled conditions to effectively produce nuclei seed; facilities for seed storage, processing and packaging; and strengthening the public-private partnerships in the seed system.

vi) Developing contractual agreements with farmers to produce pulse seeds together with the establishment of seed associations/ cooperatives.

vii) Transferring improved pulse seed production technologies to resource-poor farmers. The benefits of improved cultivars and production technologies are harnessed for the resource-poor farmers.

viii) Designing, developing and testing site-specific alternative seed system models for improving and sustaining local seed supply based on geographic and ethnic as well as administrative boundaries.

ix) Seed system requires a regulatory framework as well as a seed policy that considers regulations of an expanding and diversifying seed sector for the benefit of the smallholder farmers engaged in the seed production system.

x) Align CBSS towards conserving bio-diversity and improving the food and nutrition security.

7. Conclusions

The Community Based Seed Systems (CBSS) plays a key role in seed security and in bio-diversity conservation of food crops. It enhances the food security of rural households. Traditional varieties possess ability to grow even in adverse conditions with minimum inputs use. Sri Lankan context entails a lower Seed Replacement Rate in the food crops because of dominance of the CBSS in providing seed requirement in the country. Lack of financial

resources, storage, processing facilities and lack of knowledge on seed production systems are major constraints faced by the CBSS in Sri Lanka. CBSS are effective platforms for local collective action and empowerment in terms of the conservation and sustainable use of plant genetic resources for food and agriculture. Awareness, credit support and regulatory framework on the importance in the seed system of the farming community should be increased. Strengthening the CBSS would help to access seeds to the farmers, promote climate-resilient seeds, conserve bio-diversity and eventually contribute to the food and nutrition security.

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Invited Technical Paper

Chapter 11

Integrated Approach of National Seed Systems for Assuring Improved Seeds to the Smallholder Farmers in Nepal

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Abstract

An efficient seed system is necessary to make agribusiness profitable and to improve food and nutrition security. Existing seed systems have been analyzed and possible strategies are suggested in this paper. There are three types of seed systems (informal, non-formal and formal) based on breeding and legal status, and five types based on key players in Nepal. Informal seed system covers from 82 to 100%, whereas formal seed systems deals only 77 species among 484 domesticated crop and forage species. Informal seed system gives more assurance for smallholder farmers with regards to right time, right quantity and right affordability. The non-formal seed system is the production and marketing of improved varieties, which are not neither released nor registered by government. It also includes some features of formal and some features of informal seed system (therefore, it is also termed as semi-formal). Right quality is the major feature of formal seed system. Involvement of over 2,500 seed dealers including farming communities and 25 different tools and R&D organizations have made seed systems effective for smallholders. After few years of the variety's release or registration, seed of such varieties (which is under the formal seed system for few years) are integrated under informal seed system. The Informal seed system needs to strengthen and it should be included in education and research systems. Farmers prefer to save their own seeds from their farm, therefore, breeding varieties with such potentiality through CBSS may be good strategy for increased and assured quality seeds to smallholders.

Keywords: Smallholder, formal seed system, integrated approach, informal seed system

1. Background

An effective and sustainable seed system ensures the availability and timeliness of high-quality seeds of a wide range of varieties to farmers and other stakeholders. However, in Nepal, farmers have not yet been able to fully benefit from the advantages of using quality seeds due to a number of factors, including limited access to information, inefficiency in seed production, proper distribution and quality assurance, as well as bottlenecks caused by a lack of good seed policy on key issues such as access to credit for inputs. Agriculture Development Strategy (ADS) has visualized the improved and decentralized seed system providing timely access to quality seeds at affordable price (MoAD, 2014). Roka (2017) and has analyzed the possible impact of ADS on smallholder.

ADS focuses on commercialization and competitiveness of agriculture, however it does not clearly point out what form this commercialization will take and who will get benefited (Roka, 2017). A small group of people owns large chunks of land in the country and so controls the irrigation facilities. All kinds of facilities including bank credit at low interest rates are given only to commercially viable rich landlords. The ADS classifies rural population in three different groups: i) Small commercial farmers (1 to 5 ha), comprising 25% of rural families (selling more than 30% of their output); ii) Subsistence farmers (0.5 to 1 ha), comprising 27% of rural families; and iii) Landless and near landless (nearly half of the population), comprising 1.6 million families in number but which owned only 15% of the land. The ADS has given due recognition to small commercial farmers landholding between 1 and 5 ha and has in its plans the collaboration with farmers holding above 5 ha.

The ADS has envisioned engaging different farmers' categories with different tools for their development. Commercial banking has been stated as more appropriate for commercial farmers and microfinance for subsistence farmers. The ADS argues that performance of subsistence agriculture is unsatisfactory and that agro-chemical and transgenic intensification of production is essential for the transition from subsistence to commercial production. Traditional crop and animal combination along with diversity rich solution can be improved to increase productivity and such practices suite small farmers and it promotes healthy crop growth, reduce pests and encourages beneficial organisms.

Food and nutrition security is possible through a sustainable and competitive seed system. Formal seed production and distribution in Nepal began after

releasing the introduced rice variety CH-45 in 1959 (Joshi, 2017; SQCC, 2013; Joshi et al., 2017b). Seed testing system was started from 1961 (Thapa, 1997) and Central Seed Testing Laboratory (CSTL) was established under Agronomy Division of Department of Agriculture in 1962. Then, Agriculture Input Corporation (AIC) started seed business from 1974 by establishing a seed processing plant and a seed testing laboratory. Public sector had dominated formal seed system before 1990 and seed entrepreneurs were established only after 1991 (SQCC, 2013).

The national seed system is complex and is composed of different mechanisms, which involves a wide range of stakeholders i.e. governments, agricultural research institutes, gene banks, private-sectors, seed companies, input dealers and agro-industries, farmers and farmer organizations (SQCC, 2013). The major seed stakeholders are: Nepal Agricultural Research Council (NARC), Department of Agriculture (DoA), Agriculture Input Cooperation Ltd (AICL), NGOs (CEAPRED, LIBIRD, FORWARD), Community Based Seed Production Group (CBSPG) and Community Seed Bank (CSB) (SQCC, 2013). This paper has analyzed the existing seed system in Nepal and possible strategies are discussed for smallholder with regards to 4Rs (right time, right quality, right quantity and right affordability).

2. National Seed System

Due to varied land structure, climate, crop species, food habit and markets, different seed practices exist in the country. About 65% of total population are involved on agriculture, where local seed system is predominant in Nepal. Functional and effective seed system should have smallholder access to seeds on right time, with right quality, right quantity, and right affordability. Seed systems can be of 5 types based on key players. They are farmer led, community led, private sector led, public sector led and non-governmental organization led (Figure 1). Within each system, there are many players for making seed system more functional. Over 2,500 seed entrepreneurs are engaged in production, processing and marketing of seeds and all of them rely on public research centers to get source seeds (SQCC, 2013).

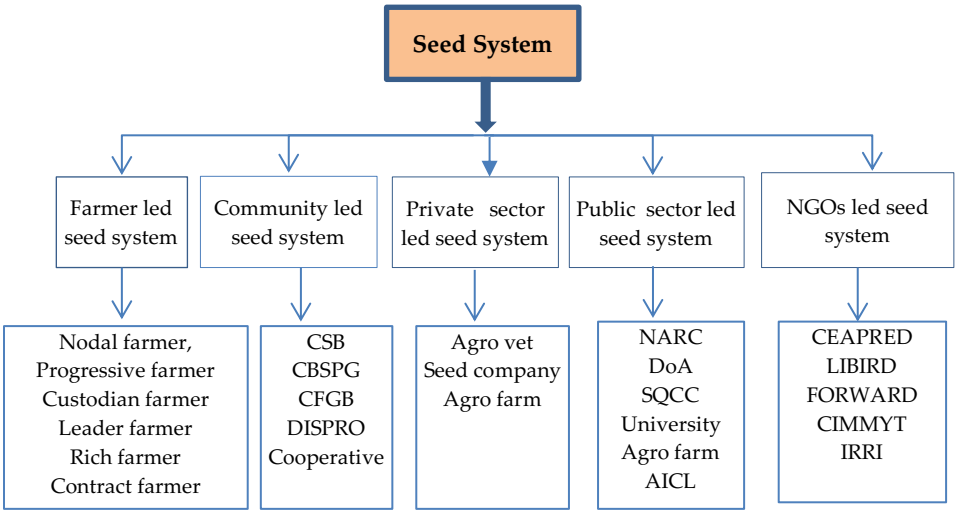

Figure 1. Types of seed system based on the key players

Note: CSB, community seed bank; CBSPG, community based seed production group; CFGB, Community Field Gene Bank; DISPRO, District Seed Self-sufficiency Program; AICL, Agriculture Input Cooperation Ltd.

Seed systems can be further broadly divided into three types based on breeding and legal status (Figure 2). They are formal seed system (FSS), non-formal seed system (NFSS) and informal seed system (ISS), however in general two seed systems have been broadly classified by Gauchan et al. (2014) and SQCC (2013). FSS is a vertically organized production and distribution of tested, released and registered varieties of seeds by public and private organizations using agreed quality control mechanism. It is guided by government act and policy, and main principles are to maintain varietal identity and purity, and to produce seed of optimal physical, physiological and genetic quality. Certified seeds marketing and distribution take place through a limited number of officially recognized seed outlets and there is a clear distinction between seed and grain.

In ISS, farmers themselves produce, disseminate, and access seed directly from their own harvest; through exchange and barter among friends, neighbors, and relatives; and through local grain markets. ISS was even successful to restore lost diversity, revive and strengthen the local crop diversity (Gauchan et al., 2018; 2016). The steps do not flow in a linear sequence and they are not monitored or controlled by government policies and regulations. ISS is not legally guided and mostly involve local landraces as well as old improved varieties.

The NFSS is the production and marketing of improved varieties though such varieties which are neither released nor registered by government. Majority of such non formal seeds are mostly imported for cereals, ornamental, vegetables and fruit species. NFSS is not officially guided and monitored. Based on the farmers' preferences, many improved but not legally notified varieties are being widely grown. NFSS can easily be converted to FSS. Additionally, based on the area coverage, seed system may be extended from family farm to community to ward to municipality to district to province to region to nation (Figure 2).

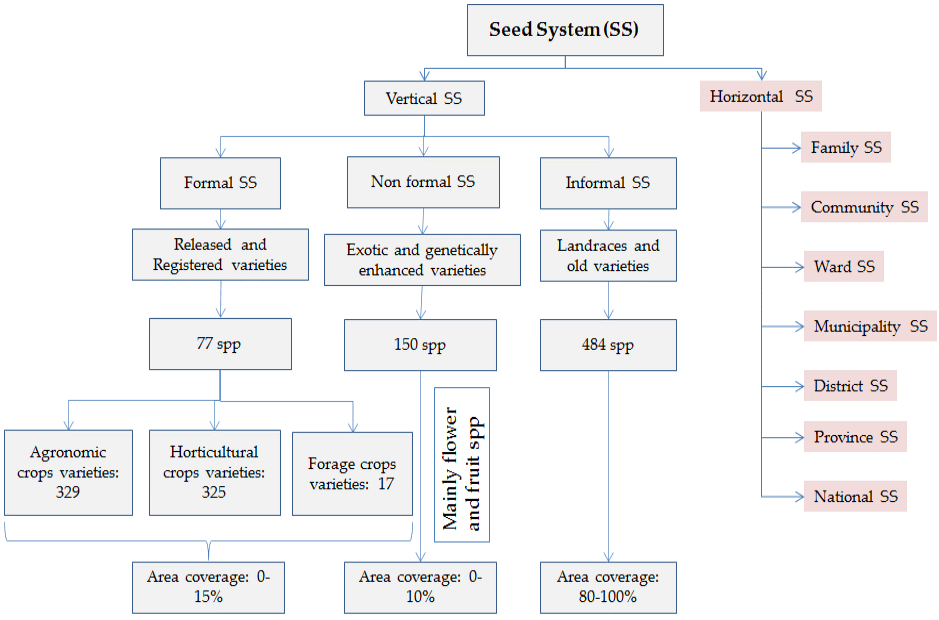

Figure 2. Types of seed system based on breeding, legal status and areas coverage

Note: SS, seed system; spp, species

These three types of seed systems are adopted considering the similar system in education. The principle and practical applicability are more or less similar to these three education systems (Dib, 1988). Formal education is defined as a systematic, organized education model, structured and administered according to a given set of laws and norms. Formal education has a well-defined set of features and non-formal is with one or more of these features of formal system is absent. Informal education is diverse from formal and non-formal education, although in certain cases it is capable of maintaining a close relationship with both. It does not correspond to an organized and systematic view of education; informal education does not necessarily include the objectives and subjects usually encompassed by the traditional

curricula. In some cases, non-formal seed system is defined as semi-formal (Francis & Waithaka, 2015).

Formal seed system is guided by *Seed Act 1988*, Seed Production Guidelines 1998 and *National Seed Policy 1999*. Under the FSS, total seeds of 28,110 tonnes (11,706 tonnes rice; 12,550 tonnes wheat; 2,887 tonnes maize, 306 tonnes vegetables and 661 tonnes others) have been produced within a country and total of 3,198 tonnes seeds (1,859 tonnes rice; 1,178 tonnes maize and 161 tonnes vegetables) were imported in 2018. The origins of 95% varieties under FSS are foreign sources. But seed quality of vegetables sold in Nepal has been deteriorating each year (Thapa, 2011). Seed Replacement Rate (SRR) is just 0-18% depending on the varieties (SQCC, 2019) (Table 1).

There is a big gap between total seed required and quality seed distributed or produced in the country. Seeds that are produced and distributed through formal seed system are considered quality seeds. Majority of the farmers save seeds of most of the crops they grow from their own farms for next season planting. Therefore, major sources of seeds are from their own farm, neighbors and relatives.

Table 1. Seed replacement rate along with demand and supply of major crops

Crop	**2016**			**2017**			**2018**		
	TSR (Tonnes)	**QSD** (Tonnes)	**SRR** (%)	**TSR** (Tonnes)	**QSD** (Tonnes)	**SRR** (%)	**TSR** (Tonnes)	**QSD** (Tonnes)	**SRR** (%)
Rice	71,237	9,621	13.5	68,145	9,472	13.9	73,477	13,533	18.4
Maize	17,648	2,294	13	17,832	2,407	13.5	23,853	3,682	15.2
Wheat	91,485	12,259	13.4	89,498	12,529	14	84,821	12,910	15.4
Lentil	8,179	352	4.3	8,179	368	4.5	8,226	397	4.8
Mustard	2,162	166	7.7	2,162	173	8.9	2,133	183	8.6
Vegetables	NA	NA	NA	NA	NA	NA	2,868	306	75

Source: SQCC (2019)

Note: TSR, Total seed required; QSD, Quality seed distributed; NA, Not available

Smallholders have low capacity to purchase seeds each season, even they maintain seeds over the seasons after buying at certain time. Smallholder farmers just need one seed to a maximum 200 kg depending on types of crops (e.g. one seed of sponge gourd, 200 kg seeds of rice) and 85% of Nepali farmers are unable to access improved seeds. Existing inclusion of crop species, varieties and area coverage of each seed system are presented in Figure 2 (Joshi et al., 2017a).

3. Smallholder Farmers

Smallholder has been used interchangeably with small-scale agriculture, family farm, subsistence farm, resource-poor farm, low-income farm, low-input farm or low-technology farm (Heidhues & Brüntrup, 2003). Murphy (2010) has defined smallholder farmers are those who are marginalized in accessing resources, information, technologies, capitals and assets. Smallholder is a farmer having operating land of less than 2 ha (World Bank, 2003). The average size of holding in Asia is only about 1 hectare (FAO, 2010). Over 85% holdings were below 2 ha and accounted for nearly 31% agricultural land in Asia. Smallholder farmers provides 80% of the food supply in Asian and sub-Saharan Africa, where 80 to 90% of planting materials are ISS (GRAIN, 2007).

Agricultural holdings under 2 ha are 91.7% in terms of number of smallholder and 68.7% in term of operated areas in the country (FAO, 2010). The agricultural holdings below 1 ha operate about 40% of cultivated land. Required farming areas for a six- member family household are 0.64, 0.52 and 0.42 ha in mountain, hills and Tarai, respectively to produce enough food (NPC, WFP & NDRI, 2010). Smallholders without land is 3% and 10% of the land-owning households have less than 0.1 ha and 53% of the land-owning households have less than 0.5 ha (CBS, 2013). In Nepal, 2.7 million smallholder farms make up for 70% of the food produced and only about one fifth of the 2.7 million smallholder farms use improved seed varieties (Rapsomanikis, 2015). Majority of their crops are neglected and underutilized, and grow mostly in sloppy marginalized upland areas.

4. Integrated Approaches for 4Rs

Integrated seed systems imply coordinated actions among the formal, non-formal and informal seed sectors. It also conveys the interdependence of such systems, with multiple links among them, with each reacting to the other and changing over time. Collaborative actions among family, community, ward (the smallest political unit), municipality, district, province and national seed system greatly support smallholders with regards to 4Rs (right time, right quantity, right quality and right affordability). Integrated seed sector development has become a very effective strategy for delivering seeds with faster and sustainable impact of seed system to a larger number of smallholders. Private and public, informal, non-formal and formal seed systems have been working coherently that helped newly developed seeds

to reach out to thousands of small scale farmers even in remote areas of the country. A conducive seed policy environment has also facilitated the development of complementary seed channels making seed industry inclusive (Pokhrel, 2012). It is also common that the seeds from the formal seed system enters into the non-formal seed systems. Among the many seed supported programs, DISSPRO[1] is the most popular, widely adopted and cheapest seed producing program with annual production of 40.4% followed by CBSPG[2] 3.83% of the total certified/ improved seeds (Pokhrel, 2012).

Generalized steps in FSS, NFSS and ISS are given in Figure 3. Relatively higher numbers of stakeholders are involved in FSS, however ISS dominates the seed systems mainly because of secured, easy access and confidence on the availability of the seeds during planting time. Integrated approaches have been imposed as much as possible in each step to effectively scale up the seeds. In developing the FSS is costly for any variety in comparison to other two systems. Landrace enhancement is also commonly implemented in many areas to improve the ISS and it is successful because of site specific variety development programs with the participation of farmers.

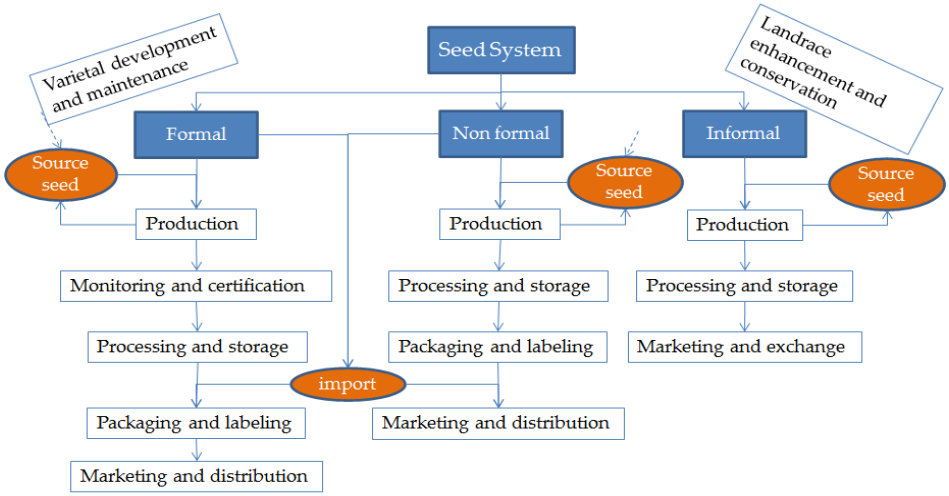

Figure 3. Steps in three types of seed systems in Nepal

[1] DISSPRO (district seed self-sufficiency program) is semi-formal seed system where seed production and marketing are through public sector, government owned national seed company and private sector as formal system.

[2] CBSPG (community based seed production group) is farmer's seed system and have good linkages with government offices and this linkage is very important for accessing source seeds, for seed certification as well as market linkages and networking. These initiatives have greatly increased access of farmers to new seed varieties.

To accelerate the availability and accessibility of seeds to the farmers, about 25 different tools, methods and distributors are in operation in Nepal (Figure 4). Integration of such different tools in both FSS and ISS have played greater role for assuring quality seeds in time of desired varieties. Both accessibility and availability are greatly enhanced through different approaches that integrate multi stakeholders, multi events, and participatory. Diversifying the sourcing and deploying diverse sets of methods for seeds testing and distribution have increased rapidly the adoption of seeds making seed system more affordable and effective.

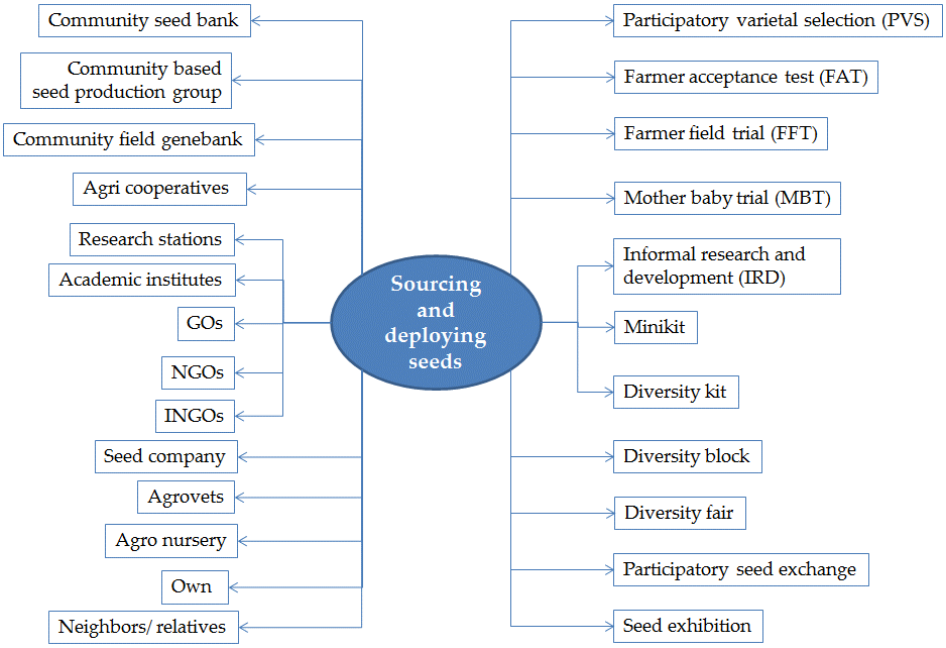

Figure 4. Sourcing and deploying methods and tools of seeds

Source: Sthapit et al. (2019); Joshi (2017); Joshi et al. (2019); Pokharel (2012); SQCC (2013)

5. Factors Affecting Seed Systems

The FSS is centralized around city areas and along the road sides. But larger number of smallholders are located remotely. Involvement of farmers in at least some steps of FSS can accelerate seeds to adopt quickly and widely. Farmers do not prefer or not able to buy seeds each season mainly because of time management, availability of seeds and budget constraints. Seeds with the potential of maintaining its quality by farmer themselves greatly affect the seed system. Modern varieties generally come up with other standard practices and management but smallholder generally uses only modern

seeds with their usual traditions of agronomical practices. Other issues affecting the seed systems are: the need for just a small amount of seeds but for diverse crops and varieties; easy and affordable access to seeds, technology and information; right information with farmer language, among others. Education and research are only on formal seed system and this is replacing the traditional seed system. Involvement of multiple seed producers may be impacted when producing quality seed because the quality of maintaining and multiplying the seeds in small areas may be difficult to assure.

Seeds are generally made available that are produced from other than cultivation sites to the growers. Single variety is generally recommended to large areas but due to larger variation in socio-economic setting and agro-ecology, this strategy is not effective. A large number of site- specific varietal options can greatly improve the seed systems. Assurance of quality seeds from reputed suppliers is the major factor to increase the seed replacement rate. However, Post-harvest technologies and facilities are poorly structured in the country and this has led the difficulty to maintain the standard of seed quality. Also, there are limited resources, unstable markets and poor planning. Due to limited funding, manpower, advanced technologies (for example, heterosis breeding, molecular breeding) have not been practiced. Researchers and growers always expect the contribution of such advanced technologies. Environment is the major factor for flourishing the seed systems and policy environment should be in favor of advancing local based diverse technologies and marketing to regional, national and global levels.

6. Recommendations to Improve the Seed Systems

i) Improvement is necessary in all types of seed systems (formal, non-formal, informal, family, community, municipality, district, province and national).

ii) In Nepal, 82-100% is informal seed system depending on the crops. For example, 82% informal seed system is on major cereals crops (rice, wheat, maize) and major vegetables, and 100% for neglected and underutilized crop species (e.g. proso millet, amaranth, foxtail millet, horse gram, rice bean, etc.). ISS is thus needed to strengthen for getting large scale impacts from functional improved seed system.

iii) All smallholders should be capacitated on quality seed systems so that ISS can work equally as FSS. ISS is effective in terms of right time, right quantity and right affordability but there are always issues of right

quality. Modern seeds if it gets integrated to ISS, farmers can get seeds at right time with right quantity and right affordability.

iv) Transforming farmers' groups into village seed enterprises could be of effective strategy as community-based seed organizations spread seed impact fast.

v) Focus should be equally given to heterogeneity, mixture, broad genetic base and diverse population of crop varieties to get space in FSS and NFS.

vi) Farmers are well familiar on diverse agricultural systems and have generated diverse traditional knowledge. This knowledge should be strengthened rather than replacing them and ignoring them completely by research and development workers and organizations.

vii) Access to information and access to seeds are the major constraints in FSS and NFSS in Nepal. Digital, farmer-friendly online information system including mobile apps may contribute significantly to facilitate access to information (for example, online information in local/ Nepali language).

viii) There are many cases of misusing the term hybrid and name of other popular variety in national seed system, therefore monitoring and evaluation mechanism should be strengthened.

ix) Varieties with the characteristics of maintaining quality seeds by farmer themselves over the years could be more effective for long term functional seed system with regards to 4Rs.

x) Farmers generally do not consider different classes of seeds and therefore, there might be good strategy to have different seed categories on different seed systems (FSS, NFS and ISS) and on different crop species (sexually propagated, vegetatively propagated, hybrids and inbreeds, etc.). Truthful labeling seeds are more appropriate in Nepal and therefore it is necessary to prescribe the minimum seed quality standards for this type of seeds.

xi) Seed testing labs including molecular are needed to be established across the country so that farmers, seed entrepreneurs, seed inspectors and researchers can have access to the lab for quality works and testing works.

xii) Registration and release process of seed varieties should be simplified and accelerated. Comprehensive guidelines for all types of crops and seeds, and three seed systems are needed to be developed.

xiii) Farmers' systems and technologies should be recognized legally including provision of farmers' rights to save, use, re-use, exchange, and sell seeds.

xiv) There are needs of technical and physical support to the seed producing farmers, extension workers and the seed entrepreneurs. The involvement of private sector should be enhanced with increased investment in seed sector.

7. Conclusions

Smallholders have integrated agriculture system, which is necessary in heterogeneous types of farming and which provides for the nutritional needs of households with small areas of land. Integration of vertical (formal, non-formal and informal seed systems) and horizontal seed systems therefore are only the option to have a seed system at the right time, with the right quantity, right quality and right affordability. Farmers generally prefer to maintain seeds themselves for next planting season. This demands the development of such varieties so that farmers can maintain seeds themselves at least for few years. Multi-stakeholders and multidisciplinary teams should involve and integrate compatible modern varieties in informal seed system for an effective national seed system.

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Invited Technical Paper

Chapter 12

Promoting Community Based Seed Systems Experience from Goth Seengar Foundation in Pakistan

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Abstract

In Pakistan, the Community Based Seed System strongly prevailed during Pre Barrage system till 1960; but the Green Revolution changed the scenario of agriculture and new high yielding varieties of seeds, pesticides and fertilizers replaced the organic agriculture system. Seed Act was introduced in 1976 by the Government of Pakistan, which was executed through Seed Corporations and other stakeholders. It was amended in 2016 and is still in practice throughout country. This case study highlights the various interventions made by Goth Seengar Foundation and are being practiced by the farmers. Moreover, some recommendations have also been proposed for strengthening the CBSS to ensure the food sovereignty of farmers and small land holder community.

Keywords: CBSS, GSF, seed system, Pakistan

1. Background

Farmers everywhere depend on seed as a fundamental input to crop production. The quality of seed variety determines the level of crop productivity and stability in production. Generally, farmers are the inventor of the seeds and preserving seeds since centuries for their use. Historically, it is evident from the ruins of Mohen jo-daro (which keeps an ancient history of 5000 years) that in Sindh (southeastern province of Pakistan) mainly the crops of wheat and cotton were grown in the fields.

Generally, the farmers were keeping seeds in sufficient quantity to satiate the requirements at community and state levels. This practice of seed preservation has been transferring from generation to generation which has been securing the future of human beings, particularly under the critical situations of wars and natural disasters. The same is being practiced in one

way or the other. However, the emergence of hybrids has changed the dynamics.

Community Based Seed System (CBSS) and food banks, therefore, need to be strengthened to ensure farmers' ownership over seed and grains, as well as food and nutritional security.

2. GSF Community Based Seed System

The establishment of formal seed system and enforcement of associated legal frameworks made the farmers market dependent. This let the foundation (GSF) to start working with farmers and is practically engaged (Figure 1) with them since 1994 regarding seed.

The foundation initiated the work, having a short experience, in 1994 with 15 farmers on pilot scale; and it expanded with the seed storage practice by 250 farmers till 1995. Then with 23 Farmer Organizations, GSF started seed bank and food security program with 1544 beneficiaries in 155 villages and resultantly, 821.25 tonnes of good quality wheat grain was produced. This successful practice was expanded in 2 more districts of Sindh. After 2010, GSF established a joint and individual seed bank, food bank and Farmers Resource Center in District Sanghar with the support of European Union. Through this intervention 1000 farmers (including 700 males and 300 females) were provided 3000 seed bags. Today, they are able to preserve/store their own seeds.

Figure 1. Farmer organization members during wheat grading process through grading machine

Currently, with the support of INGO MISEROR, the 80 male and female farmer organizations are working with GSF for the sustainable agriculture and have produced 38.23 tonnes of wheat grain; the production is used as seeds in their seed banks and also it is kept for food as well. Today out of 661

total farmers, 529 farmers (80% of the total farmers in the project areas) are maintaining their own Seed Bank and Food Bank.

Through these functional Seed Banks and Food Banks, the farmers are growing their own seed and exchange the required seeds within the farmer communities at local level, hence reduced their dependency for seed requirement on the market.

Moreover, the trend of 'Juwar/ Bajra' crop has almost been vanished after 90's. GSF facilitated and sensitized the farmers to grow Juwar and Bajra and ultimately mobilized them and built their capacity from land preparation to harvesting and resultantly Juwar cultivation has been increased to 153 growers and Bajra has been increased to 113 growers. These farmers are maintaining their own seeds banks of these crops as well.

GSF facilitated the farmers in this activity through technical supports and capacity building at every step from cultivation to seed storage.

Moreover, GSF is also promoting kitchen gardening in the area. Currently, 356 women are storing the vegetable seeds in their seed banks, growing vegetables in the Kitchen Gardens, consuming the fresh vegetables that contribute to improve nutritional security of the farming community (Figure 2).

Figure 2. Women farmers engaged in sowing their own vegetable seeds at kitchen gardening plot

The GSF is scaling-up these successful programs through various promotional activities like annual seed exchange events and demonstration visits, technical backstopping, etc.

3. Gaps and Challenges of CBSS

The GSF experiences highlights the following challenges encountered by farmers in promoting CBSS:

- Limited technical knowledge and expertise of the farmers on seed system (production, processing, grading, packaging and storage) at the community level.
- Lack of supportive legal framework for strengthening the CBSS.
- Dearth of general understanding of CBSS and its management.
- Privation of financial resources to establish CBSS and promoting seed system by farmers.
- Dearth of proper storage, processing, grading and packaging infrastructures of the seeds under CBSS.

4. Recommendations

The CBSS is an important approach to make seeds to be available to the farmers, while this approach has been encountered with quality standardization and seeds formalization (seed registration and release). Some specific recommendations are derived to strengthen CBSS in Pakistan.

- Formulation of farmers' friendly policies and legal mechanism that should formalize the CBSS's seed system adopting minimum standardized procedures.
- Developing the mechanism to provide subsidy and a formal registration approval from the government.
- Promotion of CBSS through entrepreneurship development, partnering with development agencies, and seed companies.
- Technical supports to be provided to the farmers in production, drying, grading, processing, storage of seeds.

JOINT COMMUNIQUE

(Regional Exposure Visit for Partnership to Strengthen Community Based Seed Systems in South Asia)

(5-7 November 2019/Pakistan Agricultural Research Council, Islamabad, Pakistan)

Extreme poverty and hunger are the major challenges in South Asia where agriculture plays pivotal role for increasing income, improving livelihoods and food security. The region covers around 3% of world's landmass and represents about 24% of the world's population. Agriculture is the major engine of economic development, while its growth rate is in slow pace. Around 67% of its population are smallholder family farmers, living on less than one hectare of land, with integrated farming system consisting of farms—crops, vegetables, fruits, and fisheries for their livelihoods. Seeds, at the right time, with the right quantity, right quality, and right affordability, is a basic natural resource needed by the farmers. The smallholder family farmers in the remote areas are mainly constrained by lack of access of improved seeds and majority of them using seeds from their own informal system. They produce, conserve, restore, revitalize, exchange, manage, strengthen and improve themselves at individual or at the community level at the local environment with local knowledge, skill, technology and practices. However, these informal seed systems, mainly through Community-Based Seed Systems (CBSS), are hardly recognized and receives very minimal support from governments.

Considering this context, the SAARC Agriculture Center (SAC) and the Asian Farmers Association for Sustainable Rural Development (AFA) organized the first 1st SAARC Community Based Seed System (CBSS) Forum in 19-21 May 2018 in Bangladesh, participated by representatives from the Ministries of Agriculture of the Member States of SAARC, as well as from Farmers' Organizations (FOs) of the region.

This second forum on "Regional Exposure Visit for Partnership to Strengthen Community Based Seed Systems in South Asia" held 5-7 Nov 2019 in Pakistan Agricultural Research Council, Islamabad, Pakistan, with the theme: "Partnership to Strengthen Community Based Seed Systems in South Asia" is a follow through of the ongoing efforts to strengthen CBSS in the region. In this Forum, 13 papers were presented from Country Focal Point Experts as well as from leaders of research institutions, farmers'

organizations, and from the professionals[1]. After the paper presentations, there was intensive discussions in three groups, followed by a field visit to identified successful farms related to Community Based Seed System in Islamabad, Pakistan.

As an outcome of the three-day program, and from the insights shared during the forum, the participants would like to forward the following **RECOMMENDATIONS** to strengthen the community based seed system in South Asia:

i) *Effective Management and Governance Systems of CBSS*

Smallholder family farmers in South Asia face challenges related to capacity building; formulation and effective implementation of rules and regulations; formation of community seed banks; seed storage, processing and seed treatment; high price of improved seeds; availability of good quality seeds to the farmers; and development of community based seed system in the region.

To address these challenges, the participants recommended on: capacity building of CBSS, farmers, seed producers and seed traders; formulate and implement the seed laws and policies according to their true spirit; reduce the seed gap (demand and supply) and seed access to the smallholder farmers; manage proper seed storage system, improve processing and seed treatment; and enhance the technology dissemination. The governments should encourage community seed banks at the village level. Seed produced by the different community seed banks should be supervised/ monitored by the regulatory authorities, and place into the seed -release process.

ii) Efficient Value Chain Development of Seeds Under CBSS

CBSS smallholder family farmers are challenged by limited access and affordability of certified seed of improved varieties; lack of farm machinery in the seed value chain; lack of knowledge/awareness about CBSS to farmers and market linkages; dearth of policy support to CBSS; higher rate of post-harvest losses (drying, cleaning, grading, storage); and increased risks due to climate change.

[1] The SAARC CBSS Forum was attended by 35 participants comprising of country focal point experts and FO leaders from SAARC Member States, SAC and PARC experts.

In order to address these challenges, participants recommended that public/ private sector research organizations need to be ensured the availability of basic seeds; strengthen the farmers' cooperatives; provide the machineries with subsidized incentive programs; sustainably improve the farmers market linkages; capacity building in the seed value chain development; enhance the seed storage facilities; develop climate resilient varieties; establish early warning systems; and implement crop insurance scheme towards the smallholder farmers. Furthermore, research centres are recommended to foster biotechnological programs aligning with CBSS in order to develop new varieties having high yielding and stress tolerance characteristics.

iii) *Access to Improved CBSS Seeds to the Smallholder Farmers*

CBSS farmers are handicapped with high cost of improved seeds; unreliable seed source; limited access to new varieties/ seeds; lack of awareness, limited knowledge and skill on seed production and standardization among farmers; seed legislation not favoring CBSS seed systems; and lack of farmer community organization.

The improved seeds can be accessed by the CBSS farmers through formulating policies on: providing loan in subsidized schemes from the public sector for establishing seed production farms along with the value chain; promote link among research centers & small farmers organizations; exchange of germplasm among the SAARC countries; Improve regulatory seed marketing system; and establish a CBSS network at different levels (district, sub-national, national and regional).

Report of Regional Exposure Visit for Partnership to Strengthen Community Based Seed Systems in South Asia

(5-7 November, 2019, Islamabad, Pakistan)

Introduction

South Asian Association for Regional Cooperation (SAARC) region, consisting of Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka, covers around 3% of the world's landmass and represents about 24.87% of world population. Around 67% of its population live in rural areas and they depend on agriculture, fisheries and forest for their livelihoods. As seed is the foundation of agriculture and food system, it is crucial to prioritize the national policies to be accessed to the farmers. It is proved that improved seeds alone increase about 20-30% of crop yield. However, the quality, quantity, availability and affordability of improved seeds to the rural farmers are the major challenges in developing countries including South Asia. The seed security is profoundly linked with food security and livelihoods of people including women and men farmers. In this context SAARC Agriculture Centre (SAC) in collaboration with Asian Farmer Association (AFA) and Pakistan Agricultural Research Council (PARC), jointly organized a Regional Exposure Visit for Partnership to Strengthen Community Based Seed Systems in South Asia during 5-7 November, 2019 in Islamabad, Pakistan.

Objectives

The main purpose of this regional program was to strengthen the seed systems, particularly the CBSS for agri-biodiversity conservation and improving food and nutrition security in South Asia.

Program Structure

In this 3 days program, National Experts from the SAARC Member Countries (Afghanistan, Bangladesh, Maldives, Nepal, Pakistan and Sri Lanka) presented papers on Strengthening Community Based Seed Systems for Improving Food and Nutrition Security in the country. The experts presented their papers on different thematic areas related to seed sovereignty, climate resilient, genetic resources, Intellectual Property Right (IPR) of plant breeders and farmers' rights, integrated approach of seed systems and farmers' experience sharing on seed systems. The program was followed by field visit of some major Community Based Seed System in Pakistan.

Pictures of the Program

List of Participations

Name	Designation and Address	Representation
Mr. Abdullah Abed	Head of Seed Certification Section, Ministry of Agriculture, Irrigation and Livestock, Afghanistan.	Government Focal Point Expert- Afghanistan
Mr. Md. Shahidul Islam Khan	Chief Seed Technologist, Central Seed Testing Laboratory, Seed Certification Agency, Ministry of Agriculture, Bangladesh.	Government Focal Point Expert- Bangladesh
Mr. Kul Bahadur Rai	Senior Agriculture Supervisor II, National Seed Center, Department of Agriculture, Ministry of Agriculture and Forest, Bhutan.	Government Focal Point Expert- Bhutan (Absent)
Mr. Ali Amir	Director, Ministry of Fisheries, Marine Resources and Agriculture, Maldives.	Government Focal Point Expert-Maldives
Mr. Keshav Devkota	Senior Crop Development Officer, Seed Quality Control Center Ministry of Agriculture and Livestock Development, Nepal.	Government Focal Point Expert-Nepal
Dr. Muhammad Ayub Khan	Member (Plant Science Division), Pakistan Agricultural Research Council, Islamabad.	Government Focal Point Expert- Pakistan
Mr. A. I. I. M. I Abeyrathne	Additional Commissioner General, Department of Agrarian Development, Sri Lanka.	Government Focal Point Expert- Sri Lanka
Dayananda H. L. Yasamal	Lanka Farmers' Forum, Sri Lanka.	Farmer Organization Representative, Sri Lanka
Rathnasooriya Shamila Indika	Manager, Program and Admin, MONLAR.	Farmer Organization Representative, Sri Lanka
Mehmood Tariq	Director, Swera Foundation, Chistian, Pakistan.	Farmer Organization Representative, Pakistan

Name	Designation and Address	Representation
Din Salahul	Member, Ittehad, NarangMandi, Pakistan.	Farmer Organization Representative, Pakistan
Zia Saima	Coordinator, Crofter Foundation, Lahore, Pakistan.	Farmer Organization Representative, Pakistan
Esther Penunia	Secretary General, AFA.	Video Conference
Dr. Muhammad Anjum Ali	Director General, Extension and Adaptive Research, Lahore, Pakistan.	Session Chair
Dr. Shakeel Ahmad Khan	FAO Consultant, Seed Sector, Islamabad, Pakistan.	Invited Speaker
Dr. Masood Qamar Qureshi	Director General, Federal Seed Certification and Registration Department, Islamabad, Pakistan.	Invited Speaker
Prof. Dr. Manzoor Hussain Soomro	President, ECO Science Foundation (ECOSF).	Session Chair
Dr. Ghulam Muhammad Ali	Director General, National Agricultural Research Centre (NARC), Islamabad Pakistan.	Session Chair
Dr Umar Farooq	Member (Social Sciences Division), Pakistan Agricultural Research Council (PARC), Islamabad, Pakistan.	Session Chair
Mr. Irfan Ali	Technical Staff Officer To Chairman PARC.	PARC nominated participant
Dr. Imtiaz Hussain	Director, Crop Sciences Institute, National Agricultural Research Centre (NARC), Islamabad Pakistan.	PARC nominated participant
Dr. Shaukat Ali	Director, National Institute for Genomics & Advanced Biotechnology (NIGAB).	PARC nominated participant
Dr Abid Majeed Satti	Senior Scientific Officer, Crop Sciences Institute, National Agricultural Research Centre (NARC), Islamabad Pakistan.	PARC nominated participant

Name	Designation and Address	Representation
Dr. Sikander Khan Tanveer	Program Leader (Wheat), Crop Sciences Institute, National Agricultural Research Centre (NARC), Islamabad Pakistan.	PARC nominated participant
Dr. Shahzad Asad	Director, Crop Diseases Research Institute, National Agricultural Research Centre (NARC), Islamabad Pakistan.	PARC nominated participant
Dr. Shahid Riaz Malik	Program Leader (Pulses), Crop Sciences Institute, National Agricultural Research Centre (NARC), Islamabad Pakistan.	PARC nominated participant
Dr. Najam-us-Sahar Butt	Director, SAARC Desk, MOFA Islamabad, Pakistan.	Participant / FO Representative
Dr Sadar Uddin Siddiqui	Senior Director, Bio-resource Conservation Institute (BCI), National Agricultural Research Centre (NARC), Islamabad Pakistan.	Invited speaker
Dr Muhammad Shakeel	Incharge, International Coordination, Coordination & Monitoring Division, Pakistan Agricultural Research Council (PARC), Islamabad, Pakistan.	PARC nominated participant
Dr Muhammad Ashfaque	Incharge, Planning & Research Monitoring Cell, National Agricultural Research Centre (NARC), Islamabad Pakistan.	PARC nominated participant
Dr. Muhammad Asim	Director (Plant Sciences Division), Pakistan Agricultural Research Council (PARC), Islamabad, Pakistan.	Coordinator of the Program from PARC
Md. Amirul Islam	Operations Manager, AFA.	Coordinator of the Program from PARC (Video Conference)
Dr. Rudra B. Shrestha	SPS, SAARC Agriculture Center, Dhaka, Bangladesh.	Program Coordinator

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Biobrief of Paper Contributors

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Ms. Ma. Estrella Penunia is Secretary General of the Asian Farmers' Association for Sustainable Rural Development (AFA), the Philippines.

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Mr. Keshav Devkota is a Senior Crop Development Officer in Seed Quality Control Center under the Ministry of Agriculture and Livestock Development in Nepal and his major duty is quality enhancement and quality control of seeds. He has more than 10 years of experiences at senior level on agriculture development in rural areas of the country. Mr. Devkota has MSc in Agriculture from the Institute of Agriculture and Animal Science, Tribbhuvan University, Nepal.

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Dr. Bal Krishna Joshi, a Senior Scientist in Nepal Agricultural Research Council, Nepal. He did his PhD in Plant Breeding and Genetics. He has published more than 300 articles and edited 20 books and proceedings. Dr. Joshi serves as an Editor-in-Chief of Journal of Nepal Agricultural Research Council since 2018. He also involved for teaching in Plant Breeding, Genetics, Biotechnology and Statistics in different universities. Dr Joshi received 12 different awards including National Technology Award, and Science and Technology Youth Award.

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Mr. Nazeer Ahmed Ujjan has long experience in community development, capacity building, advocacy and human rights. Currently, he serves for the small farmers of Sind Province through Goth Seenghar Foundation with supports from dedicated team of agri-scientists, researchers and campaigners and making remarkable successes in raising income and living standard of target small land holders.

Brief Biography of Editors

Dr. Rudra Bahadur Shrestha, Senior Program Specialist (Policy Planning), SAARC Agriculture Center, Dhaka, Bangladesh. Previously, he served as a Senior Agricultural Economist and Head of International Coordination and Cooperation Section, Ministry of Agriculture, Nepal; Cross Sector Advisor, Global Food Security Strategy, USAID-GON; Project Advisor, Peace Corps-Nepal; Chairperson, Nepal Rice Working Group; and Focal Point for UNDP, FAO, ILO, USAID, WBG, ADB, Danida, SDC, JICA, IFPRI, IRRI, CIMMYT, DFID in Nepal. He has PhD in Agricultural Economics from the National Pingtung University of Science and Technology, Taiwan (2015); M.Sc. in Agricultural Economics from the University of Philippines Los Banos, Philippines (2009); Master Degree in Sociology (2003) and in Economics (1999) from the Tribhuwan University, Nepal. He served as Visiting Professor in Thai Nguyen University, Vietnam, and in Purbanchal University, Nepal. His areas of expertise includes agricultural economics; strategic policy planning; farmers' right & smallholding agriculture; agriculture and food systems; rural revitalization and enterprise development; agribusiness, marketing and value chains; international trade and competitiveness; public private partnership. He was Secretary General, Nepal Agricultural Economics Society; published dozens of papers in different journals, book chapters, and edited books.

Ms. Ma. Estrella Penunia, is Secretary General of the Asian Farmers' Association for Sustainable Rural Development (AFA), a regional alliance of national Farmers' Organizations (FOs) in Asia. Established in 2002, AFA is currently composed of 20 national FOs in 16 countries, representing around 13 million small scale men and women farmers. AFA promotes farmers' rights to lands, waters, forests and seeds, sustainable, climate-resilient agro-ecological approaches in farms, fisheries and forests, strengthening farmers' cooperatives and their enterprises, women empowerment and attracting the youth to agriculture, through an integrated program on policy advocacy, capacity building and knowledge management.

Dr. Muhammad Asim, Principal Scientific Officer, Pakistan Agricultural Research Council (PARC), Islamabad Pakistan. He joined PARC in 2001 and currently serving as Coordinator in Plant Sciences Division of PARC. He did his Doctoral and M. Phil degrees in Plant Physiology from Quaid-i-Azam University, Islamabad Pakistan during 2008 and 2000, respectively. Earlier, he had obtained Master degree in Botany from University of Arid Agriculture, Rawalpindi, Pakistan in 1998. Dr. Asim visited China, Australia and Thailand as Fellowship Scientist. He authored more than fifty publications, including journal articles, book chapters, proceedings and reports.