



# Pathways for Developing the Seed Sector of Myanmar: A Scoping Study

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The study presents an integrated assessment of Myanmar's seed sector. The study includes information and analyses on regulatory environment for seed production and sales, a characterization of Myanmar's seed sector with its various seed systems, a landscape of current seed sector interventions; an analysis of three seed value-chains and Myanmar's seed farm system; as well as business opportunities for the private sector. The report concludes with a number of pathways for developing a vibrant seed sector in which quality seed of superior varieties can be accessed by farmers.

Keywords: seed, seed policy, seed sector development, Myanmar

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# Preface

This report on seed sector development is one in a series of sector assessments commissioned by the Netherlands Economic Mission in Yangon in an effort to lay the foundation for the intended Myanmar-Netherlands Cooperation Programme in the field of agriculture, livestock and fisheries; and to identify investment opportunities in the agri-food sector of Myanmar. The Myanmar Government has requested the Netherlands to explore possibilities for support and cooperation in the seed sector.

The team of experts that prepared this report has used an Integrated Seed Sector Development perspective for analysing the present situation and suggests pathways for the development of the seed sector. We think and hope that this is a useful approach and that this way of looking at the seed sector will be helpful in the further discussions among stakeholders in Myanmar.

The report underscores the need for the comprehensive development of the sector. At the same time it makes clear that there is a great opportunity to develop a vibrant seed sector, which can be a source of employment and income for many and provide the farmers of Myanmar with quality seed of superior varieties.

The observations and findings of the team came about after intensive and pleasant consultations with a range of seed sector stakeholders in Myanmar. Together with the authors, I am grateful to the farmers, government staff, researchers and development professionals who so liberally shared their insights and data over the course of the assessment.

I hope this report will be helpful for all stakeholders to further discuss on meaningful development pathways for the seed sector and assists interested companies in the further development of concrete investments in the seed sector.

Geert Westenbrink  
Agricultural Counsellor  
Netherlands Economic Mission, Yangon



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# Acknowledgements

The team is grateful for the time and information provided by all the seed sector professionals interviewed as listed in Annex 1. In particular we would like to thank the staff of the Department of Agriculture and Department of Agricultural Research of the Ministry of Agriculture and Irrigation, including the Seed Farms and the Yangon Seed Testing Laboratory. In addition, the Netherlands Mission in Yangon (Mr. Geert Westenbrink and U Saw Jackson) has been extremely helpful in arranging appointments, assisting in the field visits and providing feedback on earlier drafts of the report. Lastly, we are thankful to all assistance offered by the Agribusiness and Rural Development Consultants (ARDC).



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# List of abbreviations and measurements

ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
CBSP	Community Based Seed Production
CDI	Centre for Development Innovation
CDN	Consortium of Dutch NGOs
CIP	Centro Internacional de Papa (International Potato Centre)
CP	Charoen Pokphand Group
DAR	Department of Agricultural Research
DoA	Department of Agriculture
EU	European Union
FAO	Food and Agricultural Organization
FESR	Framework for Economic and Social Reforms
FSWG	Food Security Working Group
GDP	Gross Domestic Product
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFAD	International Fund for Agricultural Development
IRRI	International Rice Research Institute
ISSD	Integrated Seed Sector Development
ISTA	International Seed Testing Association
JICA	Japan International Cooperation Agency
LIFT	Livelihoods and Food Security Trust fund
masl	Meters above sea-level
MMK	Myanmar Kyat
MoAI	Ministry of Agriculture and Irrigation
NSC	National Seed Committee
OECD	Organisation for Economic Cooperation and Development
NGO	Non-Governmental Organization
PBR	Plant Breeders' Rights
PVP	Plant Variety Protection
PVR	Plant Variety Release
QA	Quality Assurance
TI	Transparency International
TSC	Technical Seed Committee
UPOV	International Union for Protection of new Varieties of Plants
WB	World Bank
WUR	Wageningen University and Research centre
YAU	Yezin Agricultural University

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# Measurements

MMK 1.000	=	US\$ 0.95 € 0.76 (1/12/2014)
1 hectare	=	2.47 acres
1 kg	=	0.61 viss
1 viss	=	1.64 kg
100 ticals	=	1 viss
1 basket of *:		
Black gram	=	32.7 kg
Chickpea	=	31.3 kg
Cow pea	=	32.7 kg
Green gram	=	32.7 kg
Groundnuts in shell	=	11.4 kg
Maize	=	24.9 kg
Other pulses	=	31.7 kg
Paddy	=	20.9 kg
Pigeon pea	=	32.7 kg
Sesame	=	24.5 kg
Sunflower	=	14.5 kg
Wheat	=	32.7 kg

(\* Republic of the Union of Myanmar, 2013)

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# Summary

## Introduction

In March 2014, the Netherlands Top sector Horticulture and Starting Materials, under the leadership of Dr Hans Hoogeveen, Director General Agro of the Netherlands Ministry of Economic Affairs, visited Myanmar. As a result of this mission it was, amongst others, agreed that Myanmar and the Netherlands would develop a stronger collaboration in the horticulture and seed sectors. This was reconfirmed during the visit of Myanmar's President, U Thein Sein, to the Netherlands in September 2014. Developing and modernizing the seed sector is one of the key priorities of the Government of Myanmar in advancing the agriculture sector. Myanmar, therefore, welcomes the support of the Netherlands, as it has a strong and leading international position in the seed sector. This scoping study aims at providing recommendations to a holistic and vigorous development of the seed sector and concrete suggestions for the Myanmar-Netherlands cooperation in this field.

In addition, there is a growing interest from Dutch companies, knowledge institutes and the government, jointly working together under the umbrella of the Netherlands Top sector Horticulture and Starting Materials. Jointly they would like to support the development of the seed sector by bringing in its knowledge and expertise as well as through exploring possibilities for private sector investments.

In this scoping study a first integrated assessment of the seed sector is carried out and a number of recommendations have been made. Major objectives were to:

- Make recommendations for comprehensive pathways for developing a vibrant seed sector in which more and better seed can be accessed by farmers;
- Describe the regulatory environment for seed production and sales in Myanmar (policies, laws and regulations);
- Provide a characterization of Myanmar's seed sector with its various seed systems;
- Describe the institutional landscape of seed sector stakeholders, including development projects;
- Assess potential support mechanisms and modalities for the different seed systems;
- Identify business opportunities for the private sector both for seed production and sales.

## Seed sector analysis

The seed sector of Myanmar can be characterized by three major clusters of seed systems i.e.: a) the informal seed system b) the intermediate seed system, and c) the formal seed system (see Table 1). These seed systems are specific in the crops they target, types of varieties, quality of seed and ways of seed marketing and dissemination. Overall, the different types of seed systems fulfil the specific seed demand of farmers.

Table 1

*Various seed systems within national seed sector of Myanmar*

Characteristics	Informal seed system	Intermediary	Formal seed system		
	Farmer saved seed	Community based seed production	Public seed system	Public –private seed system	Private seed system
Key actors	Framers, local traders	NGOs	Government	Government and national private seed companies	International private seed companies
Types of crops	Food crops, some cash crops	Food crops	Food crops, cash crops	Food crops, cash crops	Cash crops, food crops, feed crops
Key crops	Rice, wheat, maize, food legumes, local vegetables, potato	Rice, legumes	Rice & maize (OPV, hybrid), Sunflower (hybrid)	Rice, potato, maize	Vegetables (exotic, improved), maize & rice (hybrid)
Types of varieties	Landraces, recycled improved varieties	Improved varieties, local varieties	Improved varieties (OPV, hybrid)	Improved varieties	Improved (hybrid)
Types of seed quality	Informal seed	Certified or quality seed,	Certified or quality seed	Certified or quality seed	Certified
Dissemination /Marketing	Gift, barter, exchange, local traders, sale in village market	Exchange	Sale through contact farmers, agro-dealer shops	Sale through contact farmers, traders and agro-dealer shops	Agro-dealer shops, seed imports

The overall performance of the present system is not in line with the objectives of the overall agricultural policy. More than 90% of the seed planted of most crops is farm saved seed, while many improved varieties have been developed by research for a large number of crops (see Annex 2). In addition, only for vegetables and hybrid maize a more advanced private production and marketing system has been developed while for most other crops the performance of the seed value-chain is rather limited.

The overview of support programmes shows that most of the Development Partners, (I) NGOs and government projects concentrate on the formal, public seed system. The public-private seed system is much less developed in Myanmar. In addition, there are limited interventions in improving the informal and intermediary seed systems which still provide around 95% of seed to farmers for most crops, and are crucially important for conservation and use of plant genetic resources and climate adaptation strategies. Also, very few projects focus on new variety development. Lastly, there is limited attention for the broader seed enabling environment, i.e. related to Plant Variety Protection (PVP), the Quality Assurance system and Plant Variety Release (PVR) procedures.

### Enabling environment

There are a number of issues in the enabling environment that are hampering the growth and/or transformation of the different seed systems. The first is the relative dominance of the public sector in the production and marketing of seed. The new seed policy stipulates a transition reducing the role of the public sector from commercial operations to the provision of services and facilitation. To this end, also, greater collaboration between the public sector and the private sector is envisaged; improving the investment climate, and strengthening the seed regulations and their enforcement. This is expected to lead to more investments of reputed international companies, many of which have shown interest due to the market prospects and the excellent condition for producing seed.

The second major challenge in the seed sector is the quality assurance system. Major limitations were observed in the system of field inspections and seed testing at all levels, from the Department of Agriculture Research (DAR) Seed Farms to the Department of Agriculture (DoA) Seed Farms and from

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Seed Villages to the Inspection Lab. Bottom line is that there is a lot of emphasis on the quantity of seed produced but less so on the quality.

Lastly, some related institutional bottlenecks were mentioned, in particular the 'silo mentality' of the different government institutions and divisions. The limited communication and collaboration between DAR, the DoA Seed Division and DoA's Extension Division leads to inefficiencies in the performance of the seed chain, reducing the number of in-demand varieties reaching farmers and reducing the overall seed quality.

## **Main findings and conclusions**

### *Myanmar has a Research and Seed Farm System that can benefit millions of farmers*

Though widely criticized the DAR and DoA Seed Farms perform a crucial element in the seed-chain, availing new technologies to farmers and fulfilling an important function for food security objectives. Especially, for food crops and crops that are less commercially interesting (non-hybrid rice, legumes, oilseeds, and roots and tubers) there will remain a *raison d'être* for the seed farms. Also, our calculations show that with the existing seed prices and at average crop yields, the investigated seed farms could be operated on a cost-recovery or profit basis.

Overall, a rationalization in focus and incentives for the seed farms seems necessary. The study proposes that a number of seed farms are allowed a more semi-autonomous status. Semi-autonomous implying that: revenues from seed production flow back to the operations of the seed farm (and hence can cover for investments); that they have the freedom (within certain boundaries) to decide on which crops and varieties to grow and how to market them; and that they are encouraged to engage in arrangements with private sector parties (as investors, out growers and/or salesmen). It is expected that the increased freedom will: increase the diversity in varieties produced; enhance the quality of the foundation and registered seed; boost the overall quantities produced; and encourage more collaboration with certified seed producers. For the more commercially interesting crops (rice, maize, sunflower) the latter collaboration can be with seed companies, while for other crops (legumes, oilseeds, roots and tubers) more extended collaboration can be sought with farmer groups or the system of contact farmers.

### *Great business opportunities though some challenges remain*

For crops like hybrid rice, hybrid maize, (hybrid) vegetables and ornamental seeds, and to a lesser extent seed potatoes there are very good business opportunities for seed production and sales in Myanmar. Currently, the number of active domestic and foreign seed companies is low, while all of them indicate that Myanmar has excellent conditions for producing seed. The current business models of successful companies show that, given the low level of knowledge on improved inputs, a comprehensive approach to seed sales is necessary. Most of the successful companies, therefore, also invest in farm extension, their own marketing network and sometimes credit.

There remains a number of challenges for international companies to invest in Myanmar's seed sector. In particular, the fact that you cannot fully own a foreign company and the lack of Plant Variety Protection, limits fully fledged foreign operations (including foundation seed production and having own sales points). In addition, companies mention that the functioning of the banking sector is still poor, and that procedures for starting a company and registering varieties are unclear and lengthy.

### *A clear need for greater Seed Sector Governance and Seed Chain Coordination*

Some related institutional bottlenecks were mentioned, in particular the 'silo mentality' of the different government institutions and divisions. The limited communication and collaboration between DAR, the DoA Seed Division and DoA's Extension Division leads to inefficiencies in the performance of the seed chain and quality assurance system. In turn, this reduces the amount of quality seed of in-demand varieties reaching farmers and the overall seed quality.

With respect to the quality assurance system major limitations were observed in field inspections and seed testing. The limitations cut across all the levels, from the DAR Seed Farms to the DoA Seed Farm

and from the Seed Villages to the Seed Testing Laboratories. The bottom line is that there is a lot of emphasis on the quantity of seed produced but less so on quality.

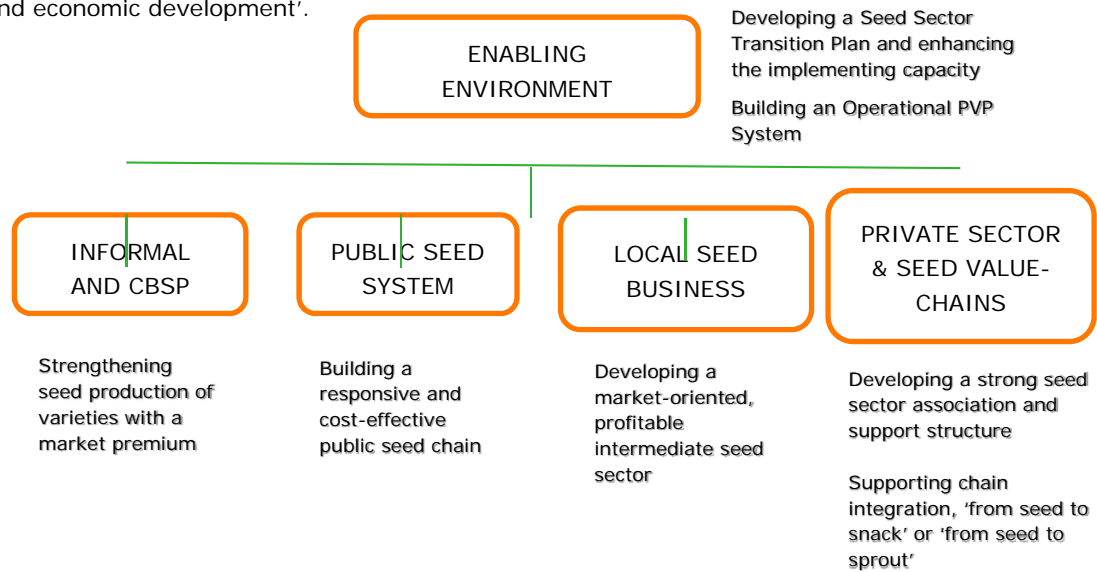
The draft Seed Policy acknowledges these challenges and proposes a number of solutions:

- The development and implementation of the new Seed Law and Regulations;
- Providing incentive schemes to the private sector;
- Better coordination of the seed chain through setting up a well-capacitated office for the National Seed Committee; and
- The establishment of a semi-autonomous Seed Certification Unit.

Implementing these policy ambitions and possible other reforms (like the seed farm and PVP system) will require a strong guidance and consistent approach by the government. To this end the National Seed Committee can play a crucial role, though its representation is limited to the public sector. Hence, a broader stakeholder dialogue is recommended that can guide the institutional changes necessary for increasing the availability of affordable seed of superior varieties. The dialogue could result in a jointly endorsed transition plan that gives hand and feet to the mentioned challenges and policy objectives.

**Tentative Activity Plan**

The Integrated Seed Sector Development (ISSD) approach ([www.issdseed.org](http://www.issdseed.org)) is helpful in comprehensively bringing together all these issues in one integrated framework, taking into account the diversity in cropping systems and levels of commercialization; as well as the institutional setting and capacities on the ground. Figure 1 shows the different pathways and projects for integrated seed sector development in Myanmar; it lists the issues and potential activities that address the systemic issues and proposes concrete improvements. The overall objective of the integrated program would be: ‘to enhance farmers’ access to quality seed of superior varieties, and contribute to food security and economic development’.



**Figure 1** Pathways and projects for integrated seed sector development in Myanmar

**Pathways and projects for of integrated seed sector development in Myanmar**

Table 1 summarizes the proposed activities and envisaged outcomes. This is a tentative list of examples of how critical bottlenecks can be tackled by concrete solutions and activities. In addition, the table provides information on the crop and regional focus, potential partners and funding opportunities. All activities combined can be taken as a full-fledged Integrated Seed Sector Development program.

Table 1

*Overview of tentative ISSD program activities in Myanmar*

Project	Problem analysis	Proposed Solutions and Activities	Envisaged outcomes	Crops and Regional Focus	Main Partner(s)	Potential funder
1. Seed Sector Governance	Lack of seed sector coordination Low quality seed Opaque PVR procedures	Developing a public-private platform for dialogue and guidance on seed sector development Developing a Seed Sector Transition Plan Strengthening the Office that supports the National Seed Committee Developing and capacitating the semi-autonomous Seed Certification Unit Assisting in developing guidelines and procedures for Plant Variety Release	Dialogue between seed sector stakeholders leading to broadly supported transition plan Well-capacitated, effective seed sector institutions Clear and transparent regulations and procedures More private sector investments in the seed sector	All crops and all States and Divisions	DoA-Seed Division, NSC, NSA, WUR, NAK	Netherlands (PSD Apps / K2K) FAO
2. Plant Variety Protection	Absence of an operational plant variety protection system	Supporting the finalization of the Plant Breeders' Rights Law Capacitating DAR, the Office of the Registrar, and the Judiciary	A well-functioning PVP system that provides sufficient guarantees for companies that want to invest, and incentives for public researchers to develop new varieties	Commercial crops and all States and Divisions	DAR, Office of the Registrar, Judiciary, Private Sector Association, NAK, WUR	Netherlands (PSD Apps / G2G)
3. Informal rice seed systems	Lack of quality, rice seed of superior varieties	Conservation and use of rice plant genetic resources Participatory Variety Selection of a wide range of superior quality rice varieties Developing sustainable, local quality seed production systems and developing local seed markets	Increased availability of quality seed of superior varieties Increased resilience (incl. climate adaptation) Higher farm income (improved gross margin) both of seed producers and users	(Initially) Rice in Delta Region (Yangon, Ayeyarwady and Rakhine)	NGOs, IRRI, WUR	LIFT (Call for Proposals for Delta Zone, late spring 2015)
4. Seed Farm reform for field crops	Insufficient early generation seed of in-demand crops and varieties	Support DoA under the Seed Sector Transition Plan to reform the Seed Farms, piloting with a few new arrangements that focus on self-sustainability and market orientation	More and better quality early generation seed available for in-demand varieties	Pilot with four seed farms (to be selected)	DAR, DoA, private sector, WUR	ADB, FAO



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5. Proof of Concept: LSBs & SSEs in Myanmar – (a) Legumes and Oilseeds; and (b) Potatoes	Lack of quality seed of superior varieties of legumes, oilseeds and potatoes	Support farmer groups and small-scale seed enterprises in seed production and marketing: entrepreneurship, quality seed production and business skills, organizational capacity and strategic linkage	Increased availability of quality seed of superior varieties Higher farm income (improved gross margin) for both seed producers and users	(Initially) legumes and oilseeds in the Central Dry Zone (Sagaing, Magway and Mandalay) and potato in Shan State	NGOs, DAR/ DoA Seed Farms, SAI/ Yezin University , WUR	LIFT (Call for Proposals for Dry Zone, Dec14-Jan15 and Shan State, spring 2015). Netherlands (potato)
6. Support to domestic and foreign seed companies	Limited presence of reputed seed companies, both in seed production and sales	Support foreign companies to invest in Myanmar with investment information, matchmaking and networks Establishing a National Seed Association (NSA)	Increased availability of improved varieties More private sector investments in the seed sector	Countrywide private investments	MoAI, NL Mission in Yangon, Seed companies	Netherlands – Ministry of Economic Affairs
7. Commercial seed value-chains	Lack of improved varieties and specialized agricultural production skills for high end markets	Support to farmers (in contract farming arrangements) on crop production and postharvest management	Increased availability of improved varieties Higher farm income (improved gross margin) Increased FDI and exports	(Initially) Mungbean, and vegetables and potato in resp. Yangon Division and Shan State	Seed companies, exporters, processors and farmers, WUR	LIFT (Call for Proposals, Private Sector window)

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# 1 Introduction

In March 2014, the Netherlands Top sector Horticulture and Starting Materials, under the leadership of Dr Hans Hoogeveen, Director General Agro of the Netherlands Ministry of Economic Affairs, visited Myanmar. As a result of this mission it was, amongst others, agreed that Myanmar and the Netherlands would develop a stronger collaboration in the horticulture and seed sectors. This was reconfirmed during the visit of Myanmar's President, U Thein Sein, to the Netherlands in September 2014. Developing and modernizing the seed sector is one of the key priorities of the Government of Myanmar in advancing the agriculture sector. Myanmar, therefore, welcomes the support of the Netherlands, as it has a strong and leading international position in the seed sector. This scoping study aims at providing recommendations to a holistic and vigorous development of the seed sector and concrete suggestions for the Myanmar-Netherlands cooperation in this field. In addition, there is a growing interest from Dutch companies, knowledge institutes and the government, jointly working together under the umbrella of the Netherlands Top sector Horticulture and Starting Materials. Jointly they would like to support the development of the seed sector by bringing in its knowledge and expertise as well as through exploring possibilities for private sector investments.

## 1.1 Background on Myanmar

Myanmar's economy is growing at a fast rate. With a GDP of close to €40 billion, of which almost 25% is related to agriculture, and a growth rate of 5, 5% annually, Myanmar is one of the fastest growing economies in South-East Asia. Total agricultural land is more than 13 million hectares, often with more than one crop per year. The country is extremely diverse, with six major agro-ecological zones, ranging from delta and river plains in Bago, to Mountainous slope land; and from a dry-land plateau to the hilly areas of Shan and Kachin States. Rainfall varies from 600mm in the Central Lowlands to 5.000mm in the mountainous coastal and Delta regions. The different altitudes, soil types and rainfall, also explain the wide variety in crops, ranging from plantation crops like cotton, sugarcane and rubber, to staple foods as rice, maize and wheat, to smallholder cash crops like vegetables, pulses and oilseeds. Rice (paddy) is by far the most important crop, taking up approximately 8 million hectares and 40% of all food production. Overall, productivity growth has been modest with an estimated 2% per year over the last decade, the main reason for production increase being area expansion (Baroang, 2014). Table 2 provides an overview of the six agro-climatic zones of the country and their main characteristics. Figures 2 and 3 provide maps of the corresponding States and Divisions, as well as the topography of the country.

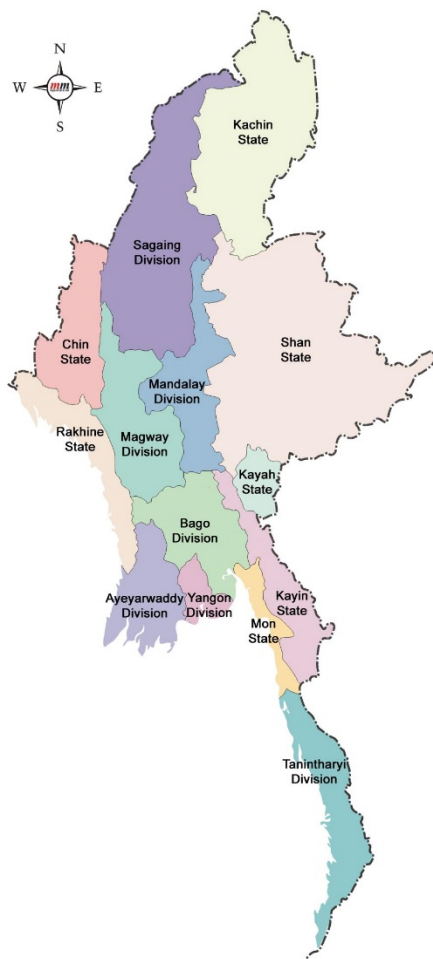
Table 2

*Agro-climatic zones of Myanmar (Baroang, 2014)*

Name	Geographical description	Administrative units	Main agricultural practices
A. Bago, Kachin Riverside Land	Upper Delta, Kachin plain, flat plain along the side of river Ayeyarwady and Sittaung, moderate rainfall (1000-2500 mm)	Ayeyarwady Division, Kachin State, Sagaing Division, Mandalay Division, and Bago Division	Rice, pulses, oilseeds, vegetables, sugarcane, tobacco, and Kaing/Kyun cultivation
B. Central Dry Zone	Central dry zone, rainfall less than 1000 mm, highest temperature in summer, flat plain, some areas with uneven topography	Magwe Division, Mandalay Division, and Sagain Division	Upland crops, oilseeds, pulses, vegetables, rice, cotton, irrigated agriculture and Kaing/Kyun cultivation
C. Delta and Coastal Lowland	Delta, lowland and mouth of rivers in coastal area, heavy rainfall (more than 2500 mm)	Ayeyarwady Division, Yangon Division, Bago Division, Mon State, Kahyin State, Tanintharyi Division and Rakhine State	Rice, pulses, oilseeds and nipa palm
D. Kachin and Coastal Upland	Mountainous, slope land, heavy rainfall (more than 2500 mm)	Kachin State, Rakhine State, Tanintharyi Division, Mon State, Kayin State, Kayah State, Yangon Division, and Bago Division	Orchard, plantation crops, fruit trees and upland agriculture
E. North, East and West Hills	Hilly areas, uneven topography, moderate to heavy rainfall, slope land	Kachin State, Chin State, and Shan State	Upland crops, shifting cultivation and fruit trees
F. Upper, Lower Myanmar and Shan Plain	Plain, upper and lower parts outside of central dry zone, plateau	Sagaing Division, Kachin State, Shan State, Bago Division, Magwe Division, Mandalay Division, and Yangon Division	Upland crops, oilseeds, pulses, vegetables and wheat

The rice sector gives a good insight into the diversity of seed systems of the country. According to the Ministry of Agriculture and Irrigation's statistics (2013): 1.5% is under hybrid varieties, 55% under high-yielding varieties; 20% under high-quality varieties, while 23% is under local varieties. The ratio between hybrids, quality seed and local seed is probably even more tilted towards the local seeds for sectors like legumes and oilseeds. Even for vegetables it is estimated that close to 90% of farmers re-use OP varieties or recycle hybrids. Currently exports of legumes and oilseeds are increasing rapidly and there is a clear incentive for farmers to invest in better inputs. In addition, quality inputs can improve productivity and quality, and hence the overall food security situation of Myanmar, where still 26% lives below the food poverty line (ADB, 2012) and 41% of children under the age of five are stunted, 30% are underweight, and 11% are wasted (UNICEF, 2009).

The Myanmar government undertakes many activities to support the seed sector, through its research and extension departments, as well as through its own seed farms. The Ministry's Seed Division aims at increasing seed production, to conduct systematic quality control and to disseminate and popularize new varieties (MoAI, 2013a). The government's seed production activities focus on rice, maize, wheat, oil crops and legumes. The government has more than 40 seed farms with a total acreage of more than 5,000 hectares, in which the production of rice seed is the most important one. Production at the seed farms is estimated at: 4 tons of breeder's seed, 136 tons of foundation (pre-basic) seed and 1940 tons of registered (basic) seed (MoAI, 2013a). Subsequently, registered seed is being multiplied by contact farmers and seed companies. According to the overview of Activities of the Department of Agriculture the government stimulates public-private partnerships between: the local administration, seed companies/associations and individual seed growers. These arrangements are sometimes also referred to as the Seed Village scheme.



**Figure 2** States and Divisions of Myanmar  
(www.myanmars.net 2012)



**Figure 3** Topography of Myanmar  
(ezillon.com 2009)

Specific issues in the government's system concern: the lack of breeders' rights (no law has been developed on PVP even though Myanmar joined WTO in 1995); the capacity of the quality assurance system (both for seed production and at market outlets) and the lengthy and opaque registration process (PVR) (ADB, 2013). From the recently adopted Seed Policy (MoAI, 2013b) it becomes clear that the government would like to embark on a transition to a more private sector led seed sector. As such the government aspires to "gradually reduce the role of the public sector [...] to mainly the provision of services and facilitation".

## 1.2 Definition of the problem

So far already substantial investments have been made in the seed sector, both in terms of research, production and support for the regulatory functions. Recently a seed policy was developed with support of the FAO and a number of donor projects are in place to support (on farm) quality seed production (e.g. through JICA and IFAD). At the same time, a comprehensive analysis of the seed sector's performance is lacking, including the analysis of the different seed systems: informal, intermediate and formal. In other Asian and African countries, Wageningen UR has gained a broad experience with this Integrated Seed Sector Development (ISSD) approach and has developed a comprehensive methodology for analysing the various seed systems and the overall enabling environment.

The overall objective of an integrated program is: to enhance farmers' access to quality seed of superior varieties, and contribute to food security and economic development. As the elements of seed

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sector development are strongly interrelated a systemic approach is taken up, combining objectives of: (1) increased productivity; (2) improved services for seed producers and companies; and (3) strengthening the policy framework.

ISSD projects contribute to strengthening the policy framework, adapting the rules and regulations to the wide variety in seed production systems and bridging the gap between informal and formal seed systems. With respect to productivity, ISSD supports a wide range of actors from public and private seed companies to local seed businesses and cooperatives, to farmer groups involved in conserving agrobiodiversity. The concept has been helpful in identifying specific activities for different types of crops, production systems and availability of supporting institutions. In parallel, ISSD has supported informed discussions and balanced decision-making on topics like: plant breeder's rights, farmers' rights, quality assurance systems and seed chain coordination.

It is alongside these notions, that the Netherlands Ministry of Economic Affairs requested an integrated assessment of Myanmar's seed sector, that provides recommendations for future activities and that explores business opportunities for the private seed sector.

## 1.3 Objectives

In this scoping study a first integrated assessment of the seed sector is carried out and a number of recommendations have been made. Major objectives were to:

- Make recommendations for comprehensive pathways for developing a vibrant seed sector in which more and better seed can be accessed by farmers;
- Describe the regulatory environment for seed production and sales in Myanmar (policies, laws and regulations);
- Provide a characterization of Myanmar's seed sector with its various seed systems;
- Describe the institutional landscape of seed sector stakeholders, including development projects;
- Assess potential support mechanisms and modalities for the different seed systems;
- Identify business opportunities for the private sector both for seed production and sales.

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## 2 Methodology

The current study was carried out following the process and tools of the Integrated Seed Sector Development (ISSD) approach which has been developed by the Centre for Development Innovation (CDI) of Wageningen UR and its partners ([www.issdseed.org](http://www.issdseed.org)). The methodology mainly consists of four analytical tools: a) a seed enabling environment analysis; b) a seed intervention landscape analysis; c) a seed systems analysis; and d) a seed value-chain analysis (table 2).

The study team consisted of three international seed consultants with expertise on seed and horticulture sector development, seed systems and policy, and private seed sector development. The team was supported by an additional national consultant in-depth analyse Myanmar's national seed sector and he also facilitated the quantitative data collection. The study team worked closely together with the Dutch Counsellor for Agriculture at the Netherlands Economic Mission in Yangon. The specifics of the literature study, mission and analyses are provided in table 3.

### a. *Literature study*

Assessment of main policies, investment and business guides, and the overview of projects activities in Myanmar. In particular focusing at:

- Agro-ecological background of the country: crops and farming systems;
- Government policies, activities and regulations;
- The business and investment climate;
- Work undertaken by IGOs and NGOs (FAO, IFAD, LIFT, JICA FSWG).

### b. *Mission to Myanmar*

From 2 till 14 November, the team carried out the mission in Myanmar, meeting with seed sector stakeholders, representing government (Ministry of Agriculture and Irrigation-Department of Agriculture, Department of Agriculture Research, Department of Planning), Yezin Agricultural University, development partners program representatives (LIFT, JICA), private seed companies (East-West, CP Maize, Know You, AAE, and agro-dealers), civil society (FSWG), and seed growers (see Annex 1). The team also visited the government seed farms, a seed testing laboratory, seed villages, private seed production fields and contact farmers in, Nay Pyi Taw, Mandalay region and Shan State (South).

### c. *Follow-up interviews*

From 20 November till 1 December a number of follow-up interviews and visits were undertaken by local consultant Naing Lin Oo. The interviews were held with government officials to get clarity on the variety list and the composition of the National Seed Committee and Technical Seed Committee. In addition, a number of field visits were held in the Dry Zone (see Annex 4 for exact locations), focussing on the performance of the seed farms and seed villages. In Annex 1 all interviewed seed sector professionals are listed.

Table 3

*Tools and key guiding questions for ISSD Myanmar scoping study*

Key tools used	Key focus/guiding questions	Information source		
		Literature review	Stakeholder consultation/ interview	Field visit
Seed systems analysis	<ul style="list-style-type: none"> <li>• What is the key domain of specific seed system (public, private, informal, mixed, other)?</li> <li>• What types of crops does the specific seed system comprise (food, cash, feed, export)? What are the major crops covered (rice, sorghum, maize, indigenous or exotic vegetables, root and tuber crops, etc.)?</li> <li>• What type of varieties are included (landraces, local varieties, modern varieties, exotic or foreign varieties)?</li> <li>• Who are the main seed value-chain operators (breeders, seed producers, seed marketing/dissemination)?</li> <li>• What types of seed quality assurance mechanisms are used (informal, quality declared, certified, accreditation)?</li> <li>• What types of distribution and marketing mechanisms are used? Who are involving?</li> </ul>	X	X	X
Seed enabling environment analysis	<ul style="list-style-type: none"> <li>• Analysis of national seed policy</li> <li>• Analysis of seed sector legislative and regulatory frameworks (seed laws and regulations, Intellectual property rights)</li> <li>• Analysis of list of released varieties and other government reports and guidelines</li> <li>• Analysis of seed sector governance</li> <li>• Analysis of seed sector economic environment</li> </ul>	X	X	X
Seed value-chain analysis	<ul style="list-style-type: none"> <li>• Identify a good indicator crop to study the seed value-chain of the respective systems</li> <li>• Identify and characterize the operators in the seed value-chain</li> <li>• Identify and characterize the service providers in the seed value-chain</li> <li>• Analyse the incentives for operators and service providers</li> <li>• Identify the key issues in the enabling environment</li> <li>• Make a SWOT to assess the overall performance of the seed value-chain</li> </ul>	X	X	X
Seed intervention landscape analysis	<ul style="list-style-type: none"> <li>• Make a summary matrix where do different programs (e.g. public, private, NGOs and donors) operate for the same seed systems</li> <li>• Which seed systems are rarely attended?</li> <li>• What are the gaps seeking overall functioning of clustered seed systems or any specific seed system?</li> <li>• Analyse for the groups of programs organized according to different domains, interventions at the level of the operators within seed value-chains</li> <li>• Analyse the interventions of the different programs for support to service providers in seed value-chains</li> <li>• Analyse interventions of the different programs that focus on the enabling environment</li> <li>• Conduct a summarized gap analysis, identify potential interventions in terms of seed systems, the value-chain operations, the services and the enabling environment</li> </ul>	X	X	X



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## 3 Seed Systems of Myanmar

The national seed sector of Myanmar is organized into three major clusters of seed systems i.e.: a) the informal seed system b) the intermediary seed system, and c) the formal seed system (see Table 3). These seed systems are unique in the crops they target, types of varieties, quality of seed and ways of seed marketing and dissemination. Overall, the different types of seed systems fulfil the specific seed demand of farmers. In our analysis we have focused on food and forage crops mainly, and to a very limited extent included tree and ornamental seed and planting materials.

*Informal seed system:* It is estimated that for most crops (including rice) over 95% of seed used by farmers is provided by the informal seed system, i.e. farm saved seed, or farmer to farmer exchange (as gift or barter) or buying grain for seed at the local market (ADB, 2013)<sup>1</sup>. Most of the varieties are local varieties, landraces or recycled varieties of food security and cash crops. Key strengths of this seed system are that the varieties are well adapted to the farmers' production system, the quality is known by farmers, and the seed is affordable due to the existence of local exchange and dissemination mechanisms. In addition, the inherent diversity of the system allows for climate change adaptation. Key limitations are that not all varieties are high yielding, that there are seed storage problems associated with seed disease and pest incidences. Further, purity problems can arise due to mixtures of seed lots after harvest, caused by inadequate seed cleaning equipment.

*Intermediary seed system:* This system, though less dominant in Myanmar, is represented by community based seed production (CBSP) programs. CBSP has been recently started through development partners' support to popularize newly released improved varieties of food legume crops such as pigeon pea, chick pea, and groundnuts and for staple food crops like superior varieties of rice. The seed quality is either assured through certification or through farmers' own seed production practices. Key strengths of this system are that the seed quality is higher, as farmers are trained on quality seed production. Limitations often are that CBSP's are project driven, and ensuring the sustainability through enhancing the market and business orientation are yet to be developed.

*Formal seed system:* Despite 40 years of seed sector development efforts, Myanmar's formal seed system still supplies less than 5% of the quality seed demand of farmers. The quality seed production data of the 2013-2014 (MoAI-DoA, 2014) season show that the formal seed system is mostly focused on rice, which is largely within the public domain. Apart from this priority crop, quality seed production of other crops such as hybrid maize, food legumes (pigeon pea, chick pea, mung bean) and oilseeds (sesame, hybrid sunflower) are produced through government and development partners support (table 4). The table further shows that there is much attention for rice seed production, while seed production for other crops is limited. The private seed sector which is yet at an infant stage, is concentrating on (hybrid) vegetables and fruits, hybrid maize and hybrid rice (see also table 5).

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<sup>1</sup> E.g. for the most popular crop, rice, we know that the formal system provides 197 ton of Registered Seed (RS) in 2014 (see table 4). If all RS would be multiplied to Certified Seed this would result in around 15.000 tons. This 15.000 tons could be used on approximately 370.000 hectares of land (at a seed rate of 40 kg/ha); which in turn is less than 5% of the rice acreage of Myanmar (which stands at around 8 million hectares).

Table 4

*Seed systems within national seed sector of Myanmar*

Characteristics	Informal seed system	Intermediary	Formal seed system		
	Farmer saved seed	Community based seed production	Public seed system	Public –private seed system	Private seed system
Key actors	Framers, local traders	NGOs	Government	Government and national private seed companies	International private seed companies
Types of crops	Food crops, some cash crops	Food crops	Food crops, cash crops	Food crops, Cash crops	Cash crops, Food crops, Feed crops
Key crops	Rice, wheat, maize, food legumes, local vegetables, Potato	Rice, Legumes	Rice & Maize (OPV, Hybrid), Sunflower (hybrid),	Rice, Potato, Maize	Vegetables (exotic, Improved), Maize & Rice (Hybrid)
Types of varieties	Landraces, Recycled improved varieties	Improved varieties, Local varieties	Improved varieties (OPV, Hybrid)	Improved varieties	Improved (Hybrid)
Types of seed quality	Informal seed	Certified or Quality seed,	Certified or Quality seed	Certified or Quality seed	Certified or Quality seed
Dissemination /Marketing	Gift, barter, exchange, or sale in village market	Exchange	Sale through contact farmers, Agro-dealers	Sale through contact farmers, Agro-dealers	Agro-dealers, Seed export

Table 5:

*Overview on formal seed production in 2013-2014 seasons in Myanmar*

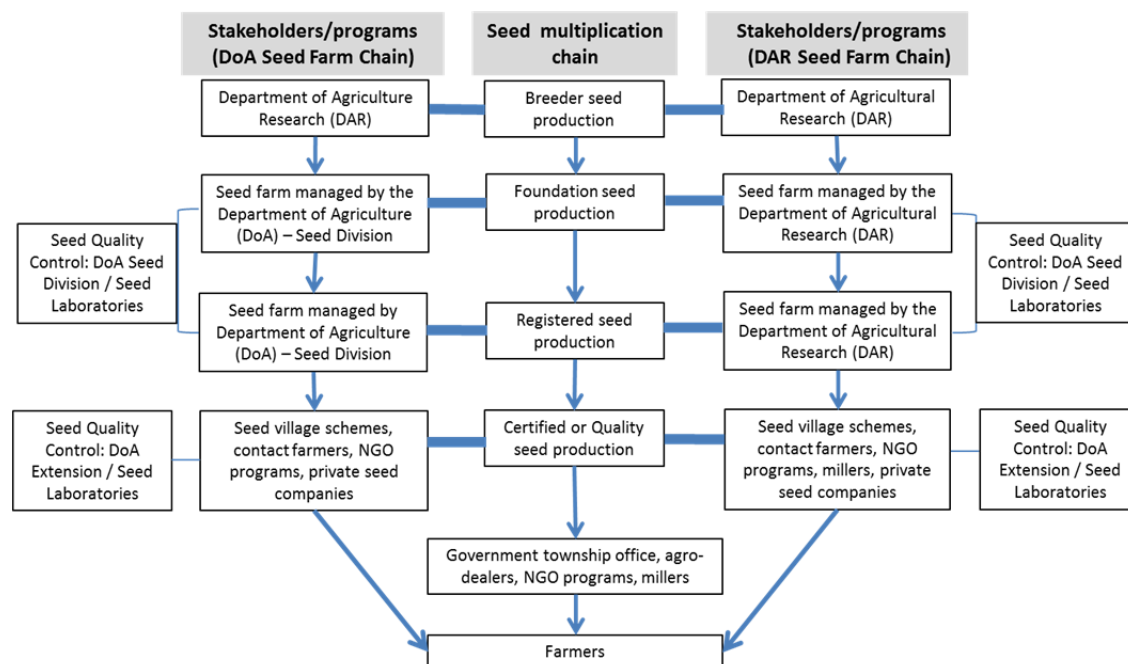
Crop	Types of seed	Area (ha)	Seed production (ton)
Rice	Breeder's seed (BS)		2.96
Rice	Foundation seed (FS)	102	3.80
Rice	Registered seed (RS)	798	197.49
Rice	Certified seed (CS)	Not available	Not available
Maize*	Certified seed (CS)	100	35.15
Green gram*	Certified seed (CS)	34	9.70
Pigeon pea*	Certified seed (CS)	279	82.63
Groundnut*	Certified seed (CS)	4	2.45
Sesame*	Certified seed (CS)	408	14.55
Sunflower	Certified seed (CS)	36	16.61

Source: MoAI, 2014, \* 2013-2014 rainy season data

The formal seed multiplication chain analysis of Myanmar shows that public sector stakeholders are dominant in the seed chain. Limited involvement of the private seed sector was found, especially for field crops. Private companies are involved in the last step of multiplication, i.e. certified seed production and dissemination of certified seed of public varieties through the agro dealer network (see figure 4).

The Department of Agricultural Research (DAR) is responsible for breeder's seed production. DAR and DoA are both involved in foundation seed and registered seed production at the 43 government farms established across the different agro-ecological production zones of Myanmar. These government

farms provide foundation and registered seed to seed village schemes, contact farmers, national private seed companies, NGO programs and millers who multiply to certified or quality seed.



**Figure 4** Formal seed multiplication of Myanmar showing various stakeholders and their functions

In practice also a lot of seed farms (both DAR and DoA) produce certified seed directly for the market. In addition, only for rice the full cycle of BS (Breeder Seed), FS (Foundation Seed), RS (Registered Seed) and CS (Certified Seed) is followed, for other crops the RS step is skipped, and the seed farms move directly from FS to CS production. Figure 4 illustrates the complex institutional task division between DAR, DoA Seed Division and DoA Extension, both in terms of production and quality assurance. In the next two chapters (4. Enabling environment, for Quality Assurance and 5.2 The role of the seed farms in the seed value-chain, for production) more information will be provided on this.



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## 4 The Enabling Environment

The enabling environment is the context that determines the extent to which stakeholders and institutions in the seed sector function and perform. The enabling environment encompasses elements of (1) the policy, legislative and regulatory framework (e.g. the seed policy, plant variety protection law and the seed regulation); (2) the overall business climate, and (3) the knowledge system (i.e. the capacity in terms of education and research). The chapter follows this tripartition.

### 4.1 Policies, laws and regulations

#### 4.1.1 Seed Policy

Myanmar recently developed a new Seed Policy (2013), with the assistance of the FAO. The draft policy has not yet been approved by the Ministry of Agriculture and Irrigation and the National Seed Committee, but already provides a good insight into the future policy directions of Myanmar's seed sector. The following elements are most noteworthy:

- The policy selects 16 crops for enhanced government programs and actions, i.e. rice, maize, black gram, green gram, chickpea, pigeon pea, cassava, sweet potato, yam, groundnut, sunflower, sesame, mango, banana, hot pepper and potato. Especially rice receives a lot of attention, targeting increased rice exports both in terms of quantity and quality;
- The policy proposes a more clear distinction between public and private activities, whereby the private sector gradually takes up a greater role in terms of registered and certified seed production, as well as internal quality assurance. The policy aims at gradually reducing "the role of the public sector from commercial operations to mainly provision of services and facilitation". This appears to be especially the case for (hybrid) rice and maize;
- In the medium term, however, the government does see a catalytic role for public seed research, foundation seed production, the overall seed quality assurance system and seed extension. In particular the approach of *Seed Villages* is being highlighted, whereby it is envisaged that organized seed growers at village level produce certified seeds on a commercial basis. In this respect, the government aims to support the gradual shift from informal to formal seed production;
- In terms of the public capacity, the government plans to provide adequate staff, facilities and budgets to DAR and the Seed Division (under DoA) to ensure the "timely supply of the required amounts of breeder's and foundation seed of public varieties; [...] the proper upkeep and operations of all public seed processing and storage facilities; [...] and increase the number of seed laboratories and recruit additional field inspectors in order to achieve sufficient seed quality control coverage";
- In addition, the government envisages a more autonomous Seed Certification Unit, a specialized agency that will be responsible for the field inspections, seed testing as well as variety registration. In time, this Unit could become more self-financing as well, charging "appropriate" seed inspection, certification and testing fees;
- With respect to Plant Variety Protection the policy envisages balancing breeder's and farmers' rights. In this line, "farmers will maintain their right to use, exchange, share or sell their farm-saved seed [...] without any restriction, provided they do not commercialize the production emanating from proprietary varieties".

#### 4.1.2 Seed Law

The Seed Law (7 January 2011) enacts the most important conditions and requirements for variety registration, quality assurance and seed sales in the country. Though the seed policy was developed after the seed law, a number of important notions are included, providing flexibility for the implementation of the seed policy:

- The opportunity for seed companies to establish own seed testing facilities and receive a government registration certificate for this;
- A number of specifications on the labelling of seed, including: trademark, variety name, weight and volume of seed, quality of seed, instruction for use, date of expiry, number and date of license, and warranty for seed quality;
- Two committees have been established under the Seed Law: the National Seed Committee (NSC) and the Technical Seed Committee (TSC). The NSC is a coordinating body, tasked with the overall guidance to the seed sector in terms of policy directions, developing regulations for quality assurance and variety release, the strategic guidance to research and the seed division, as well as the seed chain coordination. In addition, the NSC approves the release of new varieties, registration of testing laboratories and decides on the composition of the TSC. The TSC in turn is tasked with preparing all technical reports and recommendations with respect to the release of new varieties (variety trial reports), the registration of seed businesses and registration of seed testing laboratories.

An amendment to the Seed Law has been submitted to Parliament and approval is expected soon. The amendment mainly concerns the level of the charges laid out in Chapter 11, on Offences and Penalties. The approval of the draft Seed Regulation, by the Minister, has to wait until this Amendment has passed. As the law is not specifying the exact procedures for variety release, also the fees with respect to the number of adaptation trials; eligible locations (on station and/or on-farm) and number of replications, are unclear.

With respect to the Plant Variety Protection or Plant Breeders' Rights Law, a draft has been developed, but at the moment of writing it was not clear at which stage this was. Myanmar is an observer to UPOV.

#### 4.1.3 Variety Release, Quality Assurance and Plant Variety Protection in Practice

In practice we observed a number of differences between the directions and requirements stated in the laws and the enforcement and implementation. The main findings from the mission are:

- Though DoA's Seed Division is responsible for the inspections of seed production fields, in practice this does hardly take place, and is mainly limited to the Seed Farms (both DoA and DAR). The four visited seed companies and seed villages all did not receive any formal Seed Division inspections. Instead, the extension service provided support for the farmers in terms of agricultural practices, guidance on isolation distances and rouging. In the field no real rejections of seed production fields took place; mainly because extension staff is not mandated to do this;
- With respect to the Seed Testing Laboratory, most interviewed farmers and companies sent seed samples to the laboratory in Yangon (the other lab being in Mandalay). Also, the laboratory is using International Seed Testing Association (ISTA, 2004) rules and staffing is adequate. The laboratory in Yangon mainly does seed testing for rice seed (750 out of 795 samples) for all seed classes (breeder's seed, foundation seed, registered seed and certified seed). The quality testing is done on the basis of criteria like germination rate, moisture content, physical purity and admixture (e.g. weed seeds, inert material and red rice). With respect to seed health (plant pathology) no tests or post-control trials were undertaken. Especially for international seed trade, seed health checks will be necessary;
- It was unclear how many batches the Seed Division, on average, rejects. At the Seed Testing Laboratory in Yangon it was indicated that between 10-20% of samples are being rejected. These figures are relatively high, probably also due to the lack of strict field inspections by Seed Division staff. The more reputed seed companies have organized their own seed inspection and testing facilities, and hence, have become more independent from the Seed Division;
- The implementation of the Plant Variety Registration procedures are not very clear. This also has to do with the fact that there are currently no Seed Regulation or PVR guidelines. Interviewed companies mentioned that their varieties have been released or are in the process of release, but that "no one is forcing you to register". Fees for variety trials were estimated at US\$1000 per crop or US\$600 per variety. Adaptation trials of successfully released foreign varieties should take place on station (DAR) at four locations for one season;

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- The Seed Law prescribes a list of facts that need to be indicated on the seed's packaging material, amongst others: variety name, expiry date and instructions for use. In the agro dealer shops visited many seed packages were sold without these details. Also, staff of the agro dealer shop had limited knowledge on the varieties sold and their characteristics (e.g. short or long maturing varieties). Overall, there are 3093 registered fertilizer distributors in the country; a fair number of them also selling (vegetable) seeds. It was mentioned that there is a 5-day training for the registration of agro dealer shops in which information is provided on responsible agrochemical storage and use. However, these trainings are not very popular and the input shops try to dodge the trainings as much as possible;
  - A number of companies mentioned that the absence of a strong Plant Variety Protection (PVP) Law is holding back investments from private seed companies. At the Department of Agriculture it was expressed that the new PVP Law, reconciling farmers' and breeders' rights, could pass quickly. However, the main uncertainty centred on the capacity of DoA to do DUS Testing. The Distinctness, Uniformity and Stability (DUS) tests of released varieties are usually the responsibility of an Office of the Registrar (e.g. semi-autonomously or within the Ministry of Agriculture). The Office of the Registrar ensures new varieties are characterized (on morphological aspects) and holds a list of all released varieties in the country. For companies this forms the backbone for the protection of their varieties. A well-functioning PVP system includes a clear law and regulation (on the development and use of varieties, both in the informal, public and private sector), a well-functioning Office of the Registrar with well-trained staff and well-informed judges who can arbitrate in case conflicts arise.

## 4.2 Business Climate

### 4.2.1 The Economy

Myanmar has since 2011 entered a process of political and economic transformation and reform. The reforms have resulted in an economic growth of around 7% per year in 2012 and 2013, as well as increased foreign direct investments. The Government's strategic direction has been outlined in the Framework for Economic and Social Reforms (FESR). In the 2012–2015 plans the government commits itself to continuing reform, sustainable growth, and poverty reduction. The current GDP of Myanmar stands at US\$ 55.8 billion, with an average per capita income of US\$ 876 per person for the 61 million strong population (2012 figures). Projections have been made on Myanmar's economic development in the coming decades, indicating that at a medium-growth scenario the GDP per capita would rise to \$2,992–\$3,603 by 2030 (ADB, 2014).

Though much has improved in recent years, Myanmar still ranks low on the overall doing business indicators of the World Bank (WB, 2014). Out of 189 economies Myanmar ranked 178<sup>th</sup> in 2014. In particular, starting a business (rank 189<sup>th</sup>), getting credit (rank 169) and enforcing contracts (ranked 185<sup>th</sup>) are very difficult in Myanmar (all are WB Doing Business 2014 figures). Also on Transparency International's Corruption Perceptions Index Myanmar scores low with an overall 157<sup>th</sup> position out of 177 countries (TI, 2013). In discussions with seed companies and NGOs it was mentioned that the corruption is especially widespread at public enterprises, but that it did not influence their day to day business greatly. However, the companies and farmer groups did complain about the long and cumbersome procedures in starting a company, the poorly functioning banking sector and the limited access to credit.

### 4.2.2 The Foreign Investment Law

One Law particularly stands out in the business climate for foreign companies and this is the Foreign Investment Law. The law was enacted in November 2012 and provides a clear direction towards a more open and secure legal environment for foreign investors. However, the law also still leaves many questions unanswered, especially with respect to investor protection and the criteria for admitting foreign investors (OECD, 2014). The current regulatory framework and its approval process are rather complex and sometimes opaque. There is a lot of differentiation within the regulatory framework, depending on the sector and location of the investment and on whether or not the investor is foreign



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(id.). Also the new rules include an extensive list of sectors in which foreign investment is either prohibited or restricted.

In restricted sectors foreign companies can have 80% ownership; this also applies to the seed sector. The law does grant foreign investors a 5-year tax holiday and a number of other incentives. It also allows foreigners to lease land from the government or authorized parties for 50 years with extensions adding another 20 years in 10-year instalments (ADB, 2014).

One of the restricted sectors for foreign investment is the seed sector. So far foreign seed companies have mainly operated through agents, selling the imported seed. Now, an 80-20 Joint Venture is possible for both production and sales of seeds. In discussions with one seed company it became clear that a window exist for 100% foreign ownership, especially concerning seed production in the country. This window is currently being explored with MoAI and a decision is expected soon. For foreign investors also public-private partnerships with the government are promoted, e.g. for jointly managing one of the DoA seed farms. Companies expressed that such an arrangement can be promising, when the agreement clearly stipulates each responsibilities, the company is in charge of the management and the contract period is for the long term. In terms of trade facilitation, DoA indicated that they can assist new seed companies in finding a partner to set up a Joint Venture, provide support to obtain the necessary licenses and can assist in acquiring land.

#### 4.2.3 Public Investments in Agriculture

Agriculture accounts for 30% of Myanmar's GDP and 50% employment. Public expenditures in Myanmar's agricultural sector are the lowest per capita for ASEAN countries. In 2007 the entire budget of MoAI was US\$400 million, with a ratio of expenditure to agricultural GDP of 1.4% (OECD, 2014). For example, in neighbouring Thailand this is 9.7% and in Vietnam 6.7%. Out of the US\$400 million budget it is estimated that 66% was spent on irrigation through the Water Resources Utilization Department (WURD) and the Irrigation Department in FY2010-2011 (ADB, 2014). The remaining 34%, or around US\$140 million, is invested in research, extension, the regulatory functions, Yezin Agricultural University, and the seed farms. In addition, it is mentioned that the focus of most agricultural research is on increasing production, and does not account for issues of profitability, marketing and agro-ecological constraints which are important to support the development competitive farms (OECD, 2014).

Also, most research, extension, irrigation and seed multiplication activities are dedicated to rice. It is estimated that 80% of all registered seed produced and more than 90% of all seed tested at Yangon's Seed Testing Laboratory is rice. Also, most extension activities (on Good Agricultural Practices and seed multiplication) centre on rice. This has led to the relative marginalization of other crops, like pulses, oilseeds and vegetables. On the other hand, the rice focus has led to significant success, Myanmar exporting more than 1 million tons of rice in the last years. Myanmar has the potential to more than double its rice exports (in value) by diversifying and increasing its rice production (WB, 2014).

Major constraints mentioned are land tenure insecurity, limited access to finance and low availability and affordability of agricultural inputs. As one of the solutions to these constraints the government is looking at public-private arrangements that can facilitate access to credit, input access and value-addition of agricultural outputs. A success story in this respect is the work of the Myanmar Rice Federation, which is strengthening the rice supply chains together with associations of producers, millers, and traders (ADB, 2014). The companies contract the farmers and provide credit, seeds and fertilizers. They also work closely together with the extension and research staff to improve productivity and quality along the rice supply chain. A similar example is in place for the hybrid maize-animal feed chain, whereby one company, CP, facilitates the entire chain from seed to chicken.

One reason for the attractiveness of the out grower model is the relative absence of farmer groups or associations. Till now the government has not allowed for the registration of farmer groups. However, a new bylaw to the Association Law is being developed which should make it easier to register. The Law will allow for voluntary registration which ensures a legal status for groups larger than 10 members, having a budget, statutes and an office. In the latest draft farmer groups would need a recommendation letter from the Ministry of Agriculture to apply. Currently, most farmer groups are organized around credit, and not around input supply or output marketing. Often they are supported

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by the government into credit groups that operate as joint collateral for the loan (and hence exercise peer pressure to repay the loans).

## 4.3 Capacities

The main agricultural university in Myanmar is Yezin Agricultural University, which falls under the Ministry of Agriculture and Irrigation's budget. However, a new policy has been approved recently that will make Yezin Agricultural University (YAU) an independent institution with more autonomy. The country also has a number of State Agricultural Institutes for diploma level education. Most interviewed staff at the seed farms and seed companies either had a BSc degree from Yezin or a diploma of a State Agricultural Institute. In 2015 Yezin Agricultural University will accept a maximum of 600 first year students, while before this number was around 250-400. In addition, a small number of MSc students enrol yearly, e.g. in the horticulture department there were presently around five.

Overall, the number of students at YAU is regarded as too limited for the needs of the country. In addition, the private sector indicates that the curriculum at YAU is theoretical and graduates have insufficient practical skills to work in the seed sector. The university views its mandate primarily to undertake high-quality research and education, and not so much in outreach or activities at farm level. In addition, the University's resources are limited, which restricts the potential for taking in more students, both at BSc and MSc level or do more on-farm research. The new policy that will make YAU more autonomous holds the promise for also expanding the scope and scale of the University.

## 4.4 Analysis

The above observations and findings have implications for the potential development of Myanmar's seed sector. Table 6 analyses the most important issues in the enabling environment and their impact on the seed sector's performance.

Table 6.

*Analysis of the impact of the enabling environment on specific seed systems*

Enabling environment issue and example	Relevant seed systems*				Impact on seed sector performance	How can we address the issue: what is the strategic action?
	Farmer-saved seed	Community based seed production	Government seed production program	Commercial seed companies		
1 Limited field inspections and seed testing		X	X		There is serious doubt on the quality of the certified seed sold in Myanmar. The larger, commercial seed companies have all set up their own internal QA system.	The government QA system requires institutional reform, in line with the policy direction of establishing a more autonomous and self-financing Seed Certification Unit. The Seed Testing Laboratories would benefit from ISTA accreditation (at least one as reference lab).
2 Opaque Plant Variety Release procedures			X	X	It is unclear what the release procedures are; including number of trials, locations and fees. Too many (obsolete) varieties on the variety list.	Approval of the Seed Regulation, specifying PVR procedures. Establishment of Seed Certification Unit that is responsible for trials. Cleaning up of the Variety List by TSC and NSC.
3 Absence of Plant Variety Protection Law and Regulations			X	X	Limited incentives for public breeding and hesitation of foreign seed companies to invest in Myanmar.	Approval of PVP Law, with balanced farmers and breeders' rights; setting up an Office of the Registrar; training of DoA Staff and the judiciary.
4 Absence of post control trials and lack of consumer protection and information		X	X	X	The absence of plant pathology tests, post-control trials and agro dealer inspections leads to increased sales of fake or uncertified seeds (and agro-chemicals) at market outlets. There is limited information on how the seed should be used (agronomic practices, maturation time).	DoA/Seed Division capacitated to do plant pathology tests and post-control trials. Collaboration between DoA and Ministry of Home Affairs on the enforcement of the Seed Law. Improve the quality of the 5-day input dealer training. Encourage companies to provide more information on seed packages or separate leaflets in local language.
5 Difficulties for foreign seed companies to register as a 100% foreign company				X	Reluctance of foreign seed companies to invest in Myanmar.	Allow reputed foreign seed companies to have a 100% foreign company in Myanmar; bringing in new knowledge and sharing it.

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6 Limited public budget for DoA, especially for core regulatory tasks, and research and education	X	X	X	Limited attention for quality seed production, QA and consumer protection. Limited capacity to support Myanmar's seed sector.	Increased budget for regulatory functions, and agricultural research and education. More opportunities for cost recovery and value creation by government institutes.
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## 5 The Seed Value-Chain

A value-chain is a chain of activities that are undertaken in the production, processing, marketing and sales of a product of any kind; it is the process in which raw materials are transformed into a finished product that is sold and consumed (Audet-Bélanger, 2013). Three different levels can be distinguished in a value-chain. The first level of activities is handled by the value-chain operators, which are the owners of the product at some stage in the chain. Operators include producers, collectors, processors, wholesalers, retailers and consumers. The second level consists of service providers, which assist the operators in performing their tasks. Support functions include: input supply, financial services, quality assurance, extension and research (Id.). The third level is the enabling environment that refers to the environment in which operators and service providers do business. The latter has already been discussed in chapter 4 and will not be dealt with in this chapter again.

A typical seed value-chain describes a crop and variety within a specific seed system. It follows the different steps of: variety development, seed multiplication, and marketing and support services. For Myanmar we have selected three very different crops and varieties, all important for the food and nutrition security status of the country: OPV Rice in the public system; private hybrid maize; and seed potatoes. In addition, in chapter 5.2 an intermezzo is provided on the role and (potential) performance of Myanmar's seed farm system, which cuts across all crops and most of the seed systems.

### 5.1 The Public OPV Rice Seed Chain

By far the largest attention in the publically supported seed system is on rice. Out of all seed related activities undertaken by DAR and DoA it is estimated that at least 70% is dedicated to rice. Though hybrid rice is quickly coming up in the last years, the majority of the farmers still use and prefer OP varieties. Within the chain the following actors operate:

The Department of Agricultural Research has a number of research stations and seed farms where breeding activities and adaptation trials are undertaken. Currently, most of Myanmar's released varieties originated have their origin in germ plasm from the International Rice Research Institute (IRRI). Either new varieties (crossings) have been made on the basis of this germ plasm or IRRI varieties have been directly released through adaptation trials. DAR has a strong collaboration with IRRI, with whom they undertake a yearly selection of promising varieties (Nurseries and Genetic Evaluation of Rice, NGER, project). The final variety release process for new varieties takes four years (for adaptation of registered foreign varieties it is one year). In its breeding activities DAR focuses on: yield, grain quality and increasingly also stress resistance and disease tolerance. The varieties that are being used in the public system are often old varieties. Annex 2 shows the more than 90 registered rice varieties and their year of release. New varieties have difficulties entering the system due to the lengthy variety release procedure and weak collaboration between the chain actors (which is explained later).

The Department of Agricultural Research is also responsible for the production of breeder's and foundation (or pre-basic) seed at their 24 seed farms. This takes place at the DAR seed farms. It was expressed that there were issues with the maintenance breeding of a number of released rice varieties. In some cases the pedigree lines were not true to type and serious segregation in the breeder's seed had taken place. JICA currently supports DAR in improving the quality of breeder's and foundation seed production.

The next step of multiplication, to registered (or basic) seed, takes place mostly at one of the 40+ DoA seed farms, though some companies and DAR seed farms are also involved in this. At the seed farms there is much pressure on producing the targeted quantities of rice, while there are limited incentives to produce quality seed or experiment with new varieties. This has led to many complaints on the seed quality of registered seed; both by seed companies and individual seed producers. It also

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leads to the sales of registered seed for grain production, instead of completing the full multiplication cycle to certified seed. E.g. at a visited DoA seed farm it was mentioned that 70% of green gram registered seed was sold directly to agro dealer shops. It was mentioned that the seed farms receive budget on the basis of calculations for paddy rice production, instead of seed production, not taking into account the special activities and related costs for i.a. rouging, inspections, testing and extra sorting and cleaning. Most certified seed producers mentioned that for the government selected varieties, the availability of registered seed is sufficient.

Overall, the pricing of registered seed was seen as positive. The government pointed out that that registered seed typically sells at MMK 8,000 per basket (or US\$0.38 per kg) and certified seed at MMK 6,000 (or US\$ 0.29 per kg). At one of the private rice seed farms they explained that they buy the foundation seed for MMK 6,500 per basket (21 kg) or US\$0.31 per kg, while they sell the registered seed at MMK 12,500 per basket (or US\$0.60 per kg) to the farmers (who either produce certified seed or plant the RS directly for grain production) and the rejected seed was estimated at 25% (based on own field inspections). Overall, taking into account a grain price of MMK 3,500 per basket, this appears to be a profitable business for private seed producers.

The government system of certified seed production is organized along three channels: (1) seed companies; (2) out growers; and (3) seed villages (individual farmers at Township level). Roughly the flows are estimated at 60% through the seed village model, 25% by out growers and 15% by seed companies. At different townships and seed farms, government staff and farmers expressed that the link between the DAR Seed Farms, the DoA Seed Farms and the Seed Villages is weak. This has to do with the fact that the Seed Farms fall under DAR and the Seed Division, while the Seed Villages fall under the Extension Division. Communication, on e.g. the choice of varieties and quality of registered seed, has to go all the way from farmer to extension officer, to Township Manager, to District Extension Director to the District Seed Division Director and then down to the seed farms. Hence, in the public system, there is no direct communication between the producers of certified seed and the producers of registered seed. Something similar applies to the communication between producers of foundation seed (DAR) and registered seed (DoA), though biannual meetings are held in Nay Pyi Taw to plan for seed production. Suitable varieties are allocated to Townships on the basis of national maps, and detailed production targets are assigned on the basis of these maps.

The Seed Village scheme has a connotation of group production, while in practice it is more of an individual undertaking. The individuals are selected by the Township Administration on the basis of criteria like: proximity to the road (as they often also manage demonstration plots), reputation for being a good farmer and seed production skills. The seed producers interviewed receive the registered seed, in kind, through the Township office. For each basket of registered seed they repay the Township office by two baskets of certified seed. The remaining certified seed they can sell themselves directly to the surrounding farmers. There were some complaints by seed producing farmers that the varieties they got were not in high demand within their area. Overall, they expressed a clear demand for quality Posamwe-type (aromatic rice) varieties and less for the high-yielding, short straw rice varieties (non-aromatic). In addition, they complained that though they are allowed to set their own price, the seed market is not very well developed. To this end, Seed Banks are being established for legumes in the Dry Zone; the seed bank program (initiated by DoA-Extension and ACIAR) supports farmer groups in the seed production, cleaning and storage, as well as the dissemination of the seed to other villages.

Also, some informal chains were observed, where farmers buy high quality, not registered varieties from well-known rice seed producing districts, multiplying them to quality seed at their farm. An example is the Shwebo variety which predominantly comes from Thalon Village in Central Myanmar (Sagaing Division). Farmers pay up to MMK 15,000 per basket (or US\$0.71 per kg) to have this seed delivered at their farm; which is then multiplied and sold for MMK 6,000 per basket (or US\$0.29 per kg) to surrounding farmers.

With respect to the service providers, DoA's Seed Division, DoA's Extension Division and NGOs play an active role in the seed chain. Though formal seed quality inspections are limited (see also chapter 4), the Extension Division plays a role in supporting individual farmers, out growers and companies in terms of technical assistance for seed production. Though not widespread some NGOs (JICA, ACIAR, and local NGOs supported by LIFT) support a number of Seed Villages throughout the country. The following table summarizes the above observations.



Table 7:

*Matrix analysis of operators of the seed value-chain in the OP public rice system*

Seed value-chain activities – operations	Operators – stakeholders	Indication of performance	Existing incentives	Profit or profit like incentive	Issues in enabling environment
Plant genetic resource management	IRRI	Seen as one of the most successful CGIAR institutes	Public finance	Absent	Reduced donor funding
Variety development	IRRI and DAR	A diverse set of varieties are being released. Farmers select for quality rice and disease resistance.	Promotion within the system.	No breeders' rights (or potential for royalties).	No PVP Law, emphasis on quantity instead of quality.
Early generation seed production	DAR and DoA (a few companies)	One of the bottlenecks in the system; concerns in terms of: choice of variety, quantities produced and quality.	Limited incentives. A small bonus for seed farm staff if harvest is good.	Final revenues of seed farms go back to DAR/DoA.	Limited decision making power / autonomy for seed farms.
Seed multiplication	Companies, out growers, seed village scheme	Limited interest, due to current business models (out growers/seed villages). If right varieties chosen, a potentially profitable business. Major issues in terms of quality.	Extension support, free marketing and potential profitability.	Profit / Status within the Township.	Weak seed-chain coordination and limited number of available varieties. Inadequate field inspections.
Marketing and dissemination	Farmer to farmer, some through DoA	Performance is relatively good; system is flexible and DoA supports in promotion.	Profit.	For profit.	Infrastructure. No consumer protection (checks at market outlets).

## 5.2 Intermezzo: The role of the seed farms in the seed value-chain

The role of the DAR and DoA Seed Farms is pivotal for the public formal seed system. The farms have been in operation for decades. Through additional research in the Dry Zone we have looked at the performance of a number of DAR and DoA Seed Farms. The analyses mainly focused on the agronomic and economic performance, and less on the research activities (though evenly important).

The first observation we made is that yields at most of the Seed Farms are very low. Both the actual yields of the 2014 season and the self-reported average yields often score below the country's farmers' average (FAOStat data used). Though seed production is typically 10% lower than grain production (due to removal of off-types and more rigorous cleaning), the figures are still surprising as it is assumed that Seed Farm staff have better inputs and knowledge on good agricultural practices. Table 8 provides an overview of the yields of the four visited seed farms in the Dry Zone and compares these amongst each other as well with the national average.

On the basis of this we can come up with a number of observations and findings:

- The average performance of the seed farms (the figure also used for budget calculations) varies widely amongst the farms. E.g. the average yield of groundnut CS production is 0,56 tons/ha at the

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Dry Zone Agricultural Research Centre and 1,7 tons/ha at both the Oilseed Crops Research Centre and the Kyetmauktaung Seed Farm. On the contrary, in the case of sesame, the Oilseed Crops Research Centre achieves double the yield of the Dry Zone Agricultural Research Centre (0.8 t/ha vs. 0.4 t/ha);

- Overall, actual yields of all farms for the 2014 season were very low. At the Dry Zone Agricultural Research Centre they don't come close to 50% of the average farmers' yield in Myanmar, and for most crops at the Oilseed Crops Research Centre and Kyetmauktang Seed Farm they are in the range of 25-35%. Only at the Pwint Phyu Seed Farm (DoA) the most popular rice varieties (RS) score close to 100% of the average farmer's paddy yield. For three of the four seed farms the main reason for the low actual yields during the 2014 season has been drought (and lack of irrigation facilities). In addition, the farm managers mentioned lack of labour and equipment (mechanization);
- Another observation is that relatively limited varieties are being produced. For most crops it are often two to three varieties per crop. However, these varieties are relatively young. E.g. for Groundnut the two most produced varieties, Yezin-11 and -14, are from 2007 and 2011 respectively (see Annex 2 for the full variety list). In rice something similar is the case, where Sinthuka and Yadanatone were released in 2007 and 2008, and only Manawthuka was registered in 1978. This indicates that new varieties are being picked up by the seed farm system and that there is communication and collaboration between the research of DAR and the multiplication work of the seed farms.

	Harvested Acreage (acres)	Average yield (tons/h a)	Actual yield 2013 (tons/ ha)	Myanmar Average Yield Farmers 2013 (tons/ha)	Perfor- mance (AV SF: MM Farmers)	Perfor- mance (Actual SF: MM Farmers)
<b>Dry Zone Agricultural Research Center (Nayung Oo Farm, DAR)</b>						
Pigeon pea - Nyaung Oo Shwe Dingar (CS)	0.5	0.97	0.65	1.38	70%	47%
Pigeon pea - Yezin-3 (CS)	1.5	1.05	0.16	1.38	76%	12%
Pigeon pea - Thuhtaykan (CS)	0.8	1.05	0.65	1.38	76%	47%
Green gram - Yezin-11 (CS)	1.0	1.62	0.24	1.41	115%	17%
Green gram - Yezin-14 (CS)	0.4	1.62	0.81	1.41	115%	57%
Groundnut - NU08002 (CS)	1.0	0.56	0.70	1.54	37%	46%
Sesame - Sinyadana-3 (CS)	1.9	0.42	0.23	0.56	76%	40%
<b>Oilseed Crops Research Centre (Magway Farm, DAR)</b>						
Groundnut - Sinpadaytha-11 (CS) / early monsoon	1	1.7	0.96	1.54	110%	62%
Groundnut - Sinpadaytha-7 (CS) / early monsoon	2	1.7	1.06	1.54	110%	69%
Sesame - Sinyadana-3 (CS)	5	0.8	0.50	0.56	151%	89%
Sesame - Sinyadana-4 (CS)	1	0.8	0.18	0.56	151%	32%
Green Gram - Yezin-11 (CS)	1	1.4	0.40	1.41	97%	29%
Green Gram - Yezin-14 (CS)	2	1.4	0.48	1.41	97%	34%
Pigeon pea - Yezin-6 (CS)	1	1.5	0.24	1.38	105%	18%
Pigeon pea - ICPL-88039 (CS)	5	1.5	0.28	1.38	105%	20%
Groundnut Sinpadaytha-7 (CS) / mid-monsoon	1	1.7	0.42	1.54	110%	27%
Groundnut Sinpadaytha-11 (CS) / mid-monsoon	2	1.7	0.49	1.54	110%	32%
<b>Kyetmauktaung Seed Farm (DoA)</b>						
Sesame (CS) – unspecified	20	0.85	0.15	0.56	151%	27%
Pigeon pea (CS) – unspecified	25	1.45	0.32	1.38	105%	23%
Sunflower (CS) - unspecified	10	0.79	0.18	0.63	125%	28%
Green gram (CS) - unspecified	5	1.37	0.10	1.41	97%	7%
Groundnut (CS) - unspecified	5	1.69	0.39	1.54	110%	26%
Chickpea CS - ICCV 2	20	1.39	0.39	1.46	95%	26%
<b>Pwint Phyu Seed Farm (DoA)</b>						
Chickpea - Yezin-4 (CS)	0.5	NA	0.77	1.46	NA	53%
Chickpea - Yezin-6 (CS)	9.5	NA	0.77	1.46	NA	53%
Paddy - Yadanatoo (FS)	1.5	NA	2.58	3.73	NA	69%
Paddy - Manawthukha (FS)	1.5	NA	2.58	3.73	NA	69%
Paddy - Sinthukha (FS)	1.5	NA	2.58	3.73	NA	69%
Paddy - 90 Days (FS)	0.5	NA	2.58	3.73	NA	69%
Paddy - Yadanatoo (RS)	45	NA	3.61	3.73	NA	97%
Paddy - Manawthukha (RS)	31	NA	3.36	3.73	NA	90%
Paddy - Sinthukha (RS)	27.5	NA	3.36	3.73	NA	90%
Paddy - Hmawbi Kauk Nyin Hmwe (RS)	3	NA	1.56	3.73	NA	42%
Paddy - Namathalay (RS)	1	NA	1.55	3.73	NA	42%
Paddy - Layinmaung (RS)	1	NA	1.86	3.73	NA	50%

Table 8: Overview of crop productivity at four seed farms (DAR and DoA)

The second point of attention is the cost-recovery aspect. Though this objective is different for the DAR Seed Farms, also involved in research, than the DoA Seed Farms, it is worth estimating the current cost-recovery as well as the potential cost recovery. To this end, we have developed table 9, in which the average (estimated) revenue, the actual revenue for 2014 and the profits and losses are calculated. For the average revenue we have assumed current land utilization (cropping plan), the average (estimated) yields, as well as 100% sales of produce against going market prices. The figures show that the two DoA Seed Farms can be profitable, if average yields are attained and all seed is sold. The figures are even more positive for the Kyetmauktang and Pwint Phyu Seed Farms, with an MMK 33 million and MMK 16 million attainable profit respectively.

*Table 9: Average and actual profits and losses of four Seed Farms*

	Farm Acreage (acres)	Average Yield (basket/acre)	Total production (baskets)	Price per basket (MMK)	Total potential revenue (MMK/y)
Dry Zone Agricultural Research Center (Nayung Oo Farm, DAR) - Green Gram CS	78	20	1560	65000	101,400,000
Oilseeds Crops Research Centre (Magway Farm, DAR) - Sesame CS	106.1	14	1484.7	60000	89,082,000
Kyetmauktaung Seed Farm (DoA) - Sunflower F1	95	22	2090	50750	106,067,500
Pwint Phyu Seed Farm (DoA) - Rice (Sinthuka, RS)	135.5	70	9485	10000	94,850,000

*Table 10: Potential revenues for four Seed Farms, optimized land use*

	Current cultivable area (ha)	Average revenue (MMK/y)	Actual revenue (MMK/y)	Current Budget (MMK/y)	Average profit/loss (MMK/y)	Actual loss (MMK/y)
Dry Zone Agricultural Research Center (Nayung Oo Farm, DAR)	31.6	15,968,000	1,772,000	49,200,000	-33,232,000	-47,428,000
Oilseeds Crops Research Centre (Magway Farm, DAR)	23.7	15,246,000	7,500,000	69,200,000	-53,954,000	-61,700,000
Kyetmauktaung Seed Farm (DoA)	38.5	58,365,000	12,089,500	25,318,400	33,046,600	-13,228,900
Pwint Phyu Seed Farm (DoA)	54.9	80,860,000	42,600,000	65,000,000	15,860,000	-22,400,000

The DAR Farms score substantially lower. This mainly has to do with the higher overall budget allocated, which also includes higher staff and research costs. In table 10 we have tried to compensate for this while calculating the potential revenues of the seed farms. Here, we focused on the most profitable crop and variety *only*, and assumed: full land utilization; 100% sales of produce; while maintaining the cost structure as provided by the Seed Farms (including yearly administrative costs, salaries of staff, maintenance of buildings and equipment, casual labour, inputs and hiring of machinery).

*Table 11: Total costs and potential profit for four Seed Farms, optimized land use*

	Farm Acreage (acres)	Administrative Costs (MMK/y) *	Operational cost (MMK/acre) **	Total Potential cost (MMK/y)	Potential profit (MMK/y)
Dry Zone Agricultural Research Center (Nayung Oo Farm, DAR) - Green Gram CS	78	32,472,000	304,000	56,184,000	45,216,000
Oilseeds Crops Research Centre (Magway Farm, DAR) - Sesame CS	106.1	45,672,000	260,000	73,245,000	15,837,000
Kyetmauktaung Seed Farm (DoA) - Sunflower F1	95	10,918,400	130,000	23,268,400	82,799,100
Pwint Phyu Seed Farm (DoA) - Rice - Sinthuka RS	135.5	22,700,000	295,000	62,672,500	32,177,500

\* includes staff salaries, maintenance, utilities and transport

\*\* includes casual labour, inputs (seed, agrochemicals) and hiring of equipment

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Table 11 indicates that all farms can become completely self-sustainable if they focus on the commercial production of one crop. Especially for Green Gram CS at the Dry Zone Agricultural Research Centre and for Sunflower F1 production at the Pwint Phyu Seed Farm this could become a very profitable business. The figures above are just an illustration of how the system of seed farms could be made more financially self-sustainable. In other calculations, we also included a combination of important field crops, like groundnut, pigeon pea and chickpea, which still proved profitable in most cases.

On the basis of the above analysis and more qualitative interviews, we can conclude that the main challenges of the seed farms are, that there is a:

- Limited relation between the performance of the farms and the budgets allocated. Only at one farm visited, a bonus was provided because of outstanding production results;
- Limited autonomy to decide on crops and varieties that are in-demand and are relatively profitable (e.g. the case at Pwint Phyu Seed Farm that had to sell a high amount of RS rice seed as grain; while farmers requested for other longer durations varieties);
- Limited differentiation and specialization between seed farms; e.g. tables 10 and 11 show that some seed farms can become more self-sustainable when focusing on specific crops and varieties;
- Limited collaboration between DAR Seed Farms, DoA Seed Farms and DoA Extension's seed multiplication activities. This leads to the fact that much Registered Seed is being sold as Certified Seed or even as grain. Overall, the chain coordination and communication between the different institutions involved in the production of different seed classes appears to be limited;
- Limited investments in irrigation and equipment. The impact of drought at the Dry Zone Agricultural Research Centre, the Oilseeds Crop Research Centre and Kyetmauktang Seed Farm, greatly affected the attainable production and revenues.

## 5.3 Hybrid maize by the private sector

A completely different example of a seed value-chain is that of CP (Charoen Pokphand). CP is a multinational company with operations in amongst others: China, India, Thailand and Vietnam. They work according to an integrated product chain, involving: seed production, input supply, contract farming and animal feed production. It was estimated that CP's share is at least 25% of all seed utilized by farmers for maize production in Myanmar.

With respect to the seed value-chain they control all aspects of:

- The variety of hybrid maize, CP-888 is owned by the company. It was mentioned that the variety has been officially released and registered by DAR;
- The parental lines (basic seed) of the variety are imported from Thailand and multiplied in Myanmar;
- The multiplication of certified seed takes place by U Kyaw Zaw (the CP business partner) based in Taunggyi Township of Shan State. They work with around 300 out growers on 3.000 acres of land. CP has own inspectors who do the farm visits and have an own seed testing laboratory at the seed processing facility. The seed processing facility is owned by CP and built on the premises of U Kyaw Zaw. Farmers get paid MMK 530 per viss (3.6 lb) which translates to MMK 325 per kg. This includes the cob, so given a cob to grain ratio of 1:4 this amounts to US\$ 0.40 per kg, which is a fair price given the world market price of yellow maize of around US\$ 0.20 per kg;
- The final processing (seed coating) and packaging takes place in the State's Capital (Taunggyi) after which the seed is sold to farmers as part of an out grower package, including extension service, fertilizer and crop protection products. CP guarantees farmers a minimum yield and price. They work through their own agent system. The final product is being sold for MMK 17.000 per 5 kilos, or US\$ 3.4 per kg;
- In terms of the quality assurance all is being done internally by CP itself.

CP is very positive about the seed production conditions in Myanmar. They would like to expand their operations in Myanmar to also produce seed for neighbouring countries like China, Vietnam and Thailand. It appeared that challenges in the Business Climate (Foreign Investment Law) and lack of Breeders' Rights were holding back further expansion.

*Table 12: Matrix analysis of operators of the private sector hybrid maize seed value-chain*

Seed value-chain activities – operations	Operators – stakeholders	Indication of performance	Existing incentives	Profit or profit like incentive	Issues in enabling environment
Plant genetic resource management	Unknown				
Variety development	CP	CP has only one variety on the market in Myanmar (CP-888) which is appreciated for its yield and animal feed qualities.	We didn't discuss on new variety development of the company.	-	None
Early generation seed production	CP Thailand	All seed is produced by the company itself. No issues with quality.	A service for the company.	Company profit.	Currently no basic seed production in the country. Lack of PBR could be an issue.
Seed multiplication	U Kyaw Zaw and 300 out growers	Adequate amounts of good quality seed are being produced.	Contract farming price seems to be profitable. Farmers receive technical support from CP.	Profit.	
Marketing and dissemination	CP out grower scheme	Major logistical operation that works efficiently, combined with agrochemicals and extension package.	Profit.	Profit.	Limited outlets of agro dealers, so all has to be organized by the company's agents themselves.

It must be noted here that hybrid maize fulfils a very special role in the seed sectors of many countries. It is one of the crops that can be commercialized easiest (together with vegetable seeds), due to the following crop characteristics:

- Maize has a very high multiplication rate: for each kg of seed 100 kilos of grain can be produced (hence a multiplication factor of 100). This has to do with the low seed rate (20 kg per hectare) and relatively high yields (2,000 kg, provided good management and additional inputs are being used). This also implies that the relative cost for seed is low, e.g. if the seed price is 8 times the grain price, farmers still only spend only 8% of their expected revenues on seed. E.g. for other crops this is much lower, e.g. chickpea 25-30 and potatoes 10-20. Table 13 gives an overview of typical multiplication rates for major field crops;
- The second distinguishing factor is that the CP-888 is a hybrid variety. While farmers can easily multiply self or open pollinating varieties (it is estimated that a good farmer can maintain genetic properties for 5-7 generations of seed), hybrid varieties quickly lose their vigour when multiplied further. It is estimated that the yield potential is reduced by 25% for each successive step of hybrid maize multiplication. So, hybrid seed requires repeated seed purchase and hence a stable income for the company.

More general advantages of buying certified seed are: the low moisture content (and hence longer storage time) and high germination rate (due to testing and treatment).

Table 13: Seed requirements, yields and multiplication rates for field crops (Tripp, 2001)

Crop	Kg of seed required to plant one hectare	Typical yield (kg per ha)	Typical multiplication ratio
Rice (transplanted)	40	2,000-3,000	50-75
Wheat	90	1,500-3,000	17-33
Maize	20	1,500-3,000	75-150
Sorghum	10	800-1,500	80-150
Pearl millet	5	800-1,200	160-240
Soybean	50	800-1,200	16-24
Chickpea	40	1,000-1,200	25-30
Groundnuts	80	800-1,600	10-20
Potato (tons)	1.5-2.0	15-30	10-20

## 5.4 Seed Potatoes

Given the expected growth in potato consumption, the good market prices at present, the large market in neighbouring countries and the good growing conditions, the potato sector has very good prospects and could become an important sector. Seed potatoes feature in three distinct seed systems: (1) the informal system; (2) the public intermediate system; and (3) potentially also in the private formal system.

Most of the potato production in Myanmar takes place in the informal system. In the informal system farmers don't save much seed potatoes themselves, but buy from traders who source local varieties from areas that often are far away from the production areas. Two varieties are most popular, Up to Date and Kufri Joti. Recently, the Heho Research Farm has received support from the Consortium of Dutch NGOs (CDN) to expand its rapid multiplication facilities. Heho has selected the L11 variety due to its high yield and late blight resistance; though the variety is susceptible to bacterial wilt (*Ralstonia*). The activity currently takes place in the intermediate public system, but it is envisaged that it will progress to the public-private system in the medium term. Lastly, a number of private companies are eyeing the seed potato sector, i.e. through the collaboration in dedicated supply-chains by PepsiCo (for chips). In this chapter we will first discuss the current public seed potato chain (Heho) and secondly the opportunities for the private sector.

The seed value-chain analysis below describes the different steps in the rapid multiplication of the L11 variety as originating from the Heho Agricultural Research Centre. Part of the data below has been adapted from the CDN overview report: *Rapid appraisal of the Myanmar potato industry* (Haverkort, 2013).

- The L11 variety is a CIP (CGIAR) public variety that has been introduced to Myanmar by the Heho Centre (DAR);
- In the in vitro lab the initial culture is produced. This is done in containers with a growing medium. This process takes around one month and can produce up to 2,500 in vitro plantlets per year;
- The subculture is taken from these plants, where 40 cuttings can be taken from each initial culture. This can result in 100,000 plantlets per year. The process from cutting to plantlet takes 2 months, after which the plants need hardening for another 1 month;
- After this the plantlets are being transferred to a soil medium and grown to minitubers; this process takes three months and has a multiplication factor of 4, resulting potentially in 400,000 minitubers. Here you arrive at the G0 stage of the minituber and the 'normal' seed multiplication process can start;
- The first stage is then from G0 to G1 and this process takes around 6 months. The 400,000 minitubers are enough for 10 hectares, which then can produce sufficient G1 seed potatoes for 100 hectares;

- After that G1 is multiplied to G2 (basic seed) which takes another 3-4 months and can result in sufficient seed potatoes for 1,000 hectares. Given the high infection rate of the Shan State soils with bacterial wilt this is currently probably the final stage. Though in other countries a G3 stage and G4 Stage can be added, this is only possible in very virgin areas (not infected with bacterial wilt);
- This last stage (G2 to G3) again takes 3-4 months. Hence the total production time from in vitro plantlet to G3 seed potato takes at least 20 months. In Myanmar one can have 1.5 seasons per year, which after the minituber stage would require 2 years from G0 to G3 multiplication. Including the in vitro to minituber phase the entire process takes at least 2 years and 7 months.

*Table 14: Matrix analysis of operators of the seed value-chain in the public seed potato system*

Seed value-chain activities – operations	Operators – stakeholders	Indication of performance	Existing incentives	Profit or profit like incentive	Issues in enabling environment
Plant genetic resource management	CIP	One of the CGIAR institutes	Publically financed, good facilities and benefits for staff	No	Reducing donor funding
Variety development	CIP/DAR	The L11 has been developed by CIP and released by DAR for Myanmar	Limited incentive at DAR to test and release new potato varieties. Projects provide additional incentives.	No	PVR System not strong, limited finance for DAR; limited attention for potato.
Early generation seed production	DAR Heho Centre	DAR produced in vitro plantlets and minitubers; diseases (bacterial wilt) at the screen house not under control.	The project provides training and support. Otherwise within the system limited incentives.	No	There is no cost-recovery or bonus mechanism in the DAR system
Seed multiplication	Farmers	The last season fields got infected by bacterial wilt (both seed and soil born); currently searching for better locations.	Limited; multiplication time is long and reduced cash flow.	Profit after three seasons of multiplication	No proper plant health protection system / extension not very well informed on potato diseases
Marketing and dissemination	Informal	Other varieties (e.g. from China) are marketed locally	There is money to be made here. High demand and limited supply of good varieties and disease free planting material.	Profit	No checks on imported seed potatoes (seed health)

During the visit to the Heho Centre it was observed that the new technology is quite advanced for the current staff, though progress is being made. At one of the minituber screen houses crops were infected by bacterial wilt. In addition, they had difficulties to find suitable farmers to engage in G0 to G1 multiplication. Lastly, the L11 variety is rather susceptible to bacterial wilt and this creates problems in the further multiplication stages. At the same time, prices for (local) seed potatoes are good and producing and selling seed potatoes through the trader system seem very profitable.



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There appears to be a gap in terms of creating a strong linkage between the minitubers and G1 seed potatoes produced by the research centre, to capable seed potato producers (farmers) for the (G1,) G2 and G3 stages. Also, the more suitable seed potato production areas are in the insurgent areas in Shan North and Kachin State.

Given the low multiplication rate of potatoes (compared to cereals) and the relative advanced skills required for the rapid multiplication (in vitro to mini-tuber) process, it will most likely be necessary that the first stages of multiplication remain within the public sector in the short-term. Only in a few other developing countries, like Vietnam and to a lesser extent Rwanda, minituber production has been taken over (partly) by the private sector; though this took some time (5-10 years).

In China, 1 minituber costs €0.10/piece, in Ethiopia €0.25 and in the Netherlands €0.50. The current price received by the institute for the minitubers was MMK 850 per viss (1.6 kg); which translates to around US\$1 per 1,000 minitubers. This is not close to cost recovery, though if Ethiopian prices were used, the maximum production of 400,000 minitubers could result in an income of around €100.000. Once, all multiplication stages are (technically and managerially) under control, this could become a viable business case, both for the public (short-term) and private sector (medium-term). Though currently, looking at all actors in the seed value-chain, greater capacity and clearer incentives are needed. This translates to both the Heho research station (to produce quality minitubers), as well as the farmer level (to produce disease free seed potatoes).

In parallel to the seed chain of rapidly multiplying seed potatoes through the public system, there are a number of promising product-market combinations. These for example exist in the industrial or advanced high-quality cottage chips or French fries production. Or in the market for special colour, taste and size of consumption potatoes. These chains can be further enhanced through working directly with a number of lead potato processors or input suppliers. In this respect, the lead companies can assist farmers in pre-finance, input supply (seed potatoes and agrochemicals) and extension, and who could ensure a premium market outlet.

Opportunities, here, exist for international, including Dutch, seed potato companies. Though varieties introduced to Myanmar will require a high level of disease resistance (both bacterial wilt and *Phytophthora*). Given the agronomic and economic potential in Myanmar and the strong and advanced potato sector in the Netherlands, it is advisable to explore the possibility of a long term collaboration between the two countries in the field of seed potato.

## 6 Seed intervention landscape

We have documented information on eight activities of development partners, which either focus on seed sector development, or on seed within their larger agricultural development programs. We used a matrix to construct the landscape of seed interventions in Myanmar (table 15). Subsequently, we analysed their geographical focus, target crops, intervention focus and target groups. The target interventions are expressed in terms of: target crops, institutional capacity building and selection/promotion of climate adaptive crops. A separate analysis was made for five private seed companies (table 16). Their focus is on vegetables, hybrid maize and rice seed production or marketing.

*Table 15: An overview of donor funded projects in Myanmar focusing on seed sector development, or on seed within their larger agricultural development program*

Name of project, project period and donor	Key partners	Geographical focus	Target crop	Seed system focus	Intervention focus	Target groups
Development of participatory multiplication and distribution system for quality rice seed; 2011-2016 (JICA)	DoA, DAR	Nay Pyi Taw	Rice	Public seed system	Human resource development in DAR & DoA on breeder's seed, foundation seed and registered seed production	DAR and DoA staff
Support to development of hybrid rice in Myanmar; 2013-2015 (FAO)	DAR, DoA	Nay Pyi Taw, Mandalay, Sagaing, Bago, Ayeyarwaddy, Rakhine, Magway, Yangon	Rice (Hybrid)	Public seed system	Institutional capacity strengthening and demonstration of hybrid rice seed production	DAR & DoA staff, seed growers
Diversification & intensification of rice based system in lower Myanmar; 2012-2016 (ACIAR)	DAR, DoA, IRRI	Ayeyarwaddy, Bago	Rice	Public seed system	Promote adoption of new rice varieties and alternative crop management options to increase rice productivity in rice-rice and rice-pulse cropping systems. Production of submergence-tolerant rice seed by DAR and distribution to flood-affected areas through DoA	Smallholder farmers
Increasing production of legume based farming system in the Central Dry zone of Myanmar; 2013-2016 (ACIAR)	DAR, DoA, YAU, ICRISAT	Mandalay, Sagaing, Bago, Magway, Nay Pyi Taw, Yangon	Pigeon pea, chick pea, groundnut	Community based seed production	Develop new, high-yielding varieties of pigeon pea, groundnut and chickpea, and to improve nutrient management and agronomic management of the legume-based farming system, enhance the capacity for RD&E in the relevant agencies in Myanmar, promote community-based seed production and distribution	DAR & DoA seed farm staff, farmers

Livelihood and Food Security Trust (LIFT) funded projects in Delta region (LIFT)	IRRI, Radanar Ayar, Mercy crops, DoA	Bogale	Rice	Community based seed production	Increase the availability of quality seed of improved or locally adapted rice varieties that have a high yield and higher tolerance to submergence and salinity. Activities includes participatory varietal selection (PVS) and seed multiplication	Smallholder farmers
Livelihood and Food Security Trust (LIFT) funded projects in the Dry Zone (LIFT)	Several NGOs	Mandalay and Magway	Pigeon pea, mung bean, rice	Informal and intermediary	Local multiplication and seed banks	Smallholder farmers
Post-harvest technology assistance for Myanmar's agricultural products; 2011-2014 (KOICA)	DoA	Mandalay	Rice, Beans	Public seed system	Distribution of quality seed to project farmers	Smallholder farmers

*Table 16: An overview of a number of private seed companies involved in seed production/ multiplication and/or seed extension services (excludes companies who only import seed and sell)*

Name of company,	Local partners	Geographical focus	Target crop	Key activities
East-West	DOA, DAR, YAU	Production: Mandalay, Sales: Country-wide, Extension: Shan, Nay Pyi Taw, Bago, Rakhine	Vegetables, papaya, melon sweet corn, mung bean	Investment as integrated seed company (seed production with contract farmers and seed processing, extension, research and sales)
CP Company	Joint venture with local company, Contract farmers	Production: Shan State (South) , Sales: country-wide	Maize (hybrid)	Hybrid maize seed production with 300 contract farmers, in house seed processing and quality assurance facilities
Know You company	Contract farmers	Nay Pyi Taw, Mandalay	Tomato, mask melon, watermelon, cucumber, long-bean	Quality seed production with contract farmers
Bejo Sheetal company	Contract farmers	Nay Pyi Taw	Chilli	Quality seed production with contract farmers
Advanced Agricultural Engineering Co Ltd (AAE)	Own seed production land	Yangon	Rice	Registered seed production, in house seed processing and packaging facilities, supply to farmers and millers for certified seed production

We further structured our analysis in order to identify what types of seed systems are targeted, how seed chain management is organized, how the seed service provision operates, and how seed enabling environment issues are being covered (table 17). The latter part of the analysis enabled us to understand the nature of seed interventions in more detail, and identify potential gaps to provide the basis for integrated seed sector development in Myanmar. It shows that most of the seed programs concentrate on the public seed system domain. The public-private seed system is much less developed in Myanmar. There are very limited interventions in improving the informal seed system which still provides around 95% of seed to farmers for major crops. In addition, very few projects focus on new variety development. In addition, there is limited attention for the broader seed enabling environment, related to Plant Variety Protection (PVP), the Quality Assurance (QA) system and Plant Variety Release (PVR) procedures.

Table 17: Overview of seed intervention of various programs in Myanmar

Key intervention areas	Development partners project					Private seed companies				
	JICA project	FAO-Hybrid rice seed project	ACIAR-Rice seed project	ACIAR-Food legumes project	LIFT Delta region project	KOICA project	East-west	CP company	Know you	AAE
<b>Seed system focus</b>										
Farmer saved seed system										
Community based seed production system					X					
Public seed system	X	X	X	X		X				
Public-private seed system										X
International private seed programs							X	X	X	
<b>Seed chain management</b>										
Crop genetic resource management			X	X						
Plant breeding and variety development				X						
Breeder's seed production	X	X		X						
Foundation seed production		X		X						
Registered seed production		X		X						
Certified seed production		X	X	X	X	X	X	X	X	X
Seed marketing		X		X	X		X	X	X	X
<b>Seed service provision</b>										
Variety testing, release/ administration	X			X			X			
Quality assurance	X		X	X			X	X	X	X
Processing, conditioning, packaging			X	X			X	X	X	X
Financial services			X	X				X	X	X
Agro-chemicals, machinery support			X	X				X	X	X
Extension/promotion			X	X			X	X	X	X
Market information							X		X	X
<b>Seed enabling environment</b>										
Plant variety protection (PVP) law										
Genetic resource policies										
Seed policies, laws, regulatory framework										
Trade and economic policies										
Role of gender (particularly women and youth)			X							

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## 7 Main findings and conclusions

The previous chapters all captured the different functions seed performs in Myanmar's agriculture sector. The chapters highlighted the complex nature of seed; dealing with all crops, all production systems and a wide array of policies, institutions and stakeholders. As such, the role of seed in the agricultural system is multidimensional, depending on the functions the seed performs<sup>2</sup>:

- **Biodiversity:** seed produced in the informal system is often a mix of local landraces, newly introduced varieties and scientifically improved varieties. The wide diversity in crops and varieties protects the farmers to sudden changes in agro-climatic condition and provides the input for the formal breeding programs. In Myanmar, the agro-biodiversity in rice is well recognized and the example provided on the local Schwebo (Posamwe) rice variety indicates the importance of these local varieties in the local farming systems;
- **Culture and traditions:** seed often plays an important role in the local agricultural systems, in which seed is re-used, exchanged and bartered. In this area, also the debate on seed sovereignty and farmers' rights takes place – in which communities demand rights on the protection of their local varieties (e.g. benefit sharing arrangements) and free use of varieties of important food crops (farmers' rights). This as opposed to more stringent plant variety protection where breeders have greater protection to collect royalties for their exclusively developed varieties;
- **Food security:** seed is a key driver for achieving and maintaining food security, both at national and local level. Food security directly relates to seed security as without seed no crop can be grown. It also explains Myanmar's preoccupation with rice research and seed multiplication as each citizen consumes on average 250 kg of rice. Hence, a reduced availability of rice (seed) directly impacts the food security situation of the country. It also explains the government's priorities for other food security crops, like food legumes (black gram, pigeon pea and chick pea) and roots and tubers (cassava, (sweet) potato);
- **Knowledge and technology:** seed is also a transfer mechanism for new knowledge and technologies. This role became particularly clear in the seed value-chain chapters where (international) research centers and private parties introduced new varieties, causing great changes in yields but also in the associated agronomic practices. E.g. the CP package of seeds, agrochemicals and extension has transformed maize production and marketing in Myanmar;
- **Business Development:** seed can also be a high-value commodity with substantial profits to be gained for seed companies and seed producer farmers. A number of examples are provided in the text where significant profits can be made if seeds of the right varieties are multiplied and reach the farmer. In the Myanmar case the potential is often not reached due to gaps in the seed chain or issues in the enabling environment and business climate;

The above functions also justify an integrated sector approach, as improvements in one aspect (e.g. strict farmers' right) can harm progress in another (knowledge and technology, and business development). Hence, a balanced approach is necessary to achieve sector growth.

Taking this as a background, the following conclusions can be drawn:

### **Five seed systems each catering for different combinations of crops, farming systems and markets**

The analysis distinguished five distinct seed systems, each with its distinct characteristics.

- The first is the informal seed system that includes landraces and recycled improved varieties of the major food and cash crops. Still, for most crops (including rice) this system comprises more than 95% of all seed used by farmers;

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<sup>2</sup> Typology adapted from: Louwaars (2007): Seeds of confusion

- The second system is characterized by community based seed production. Often organized as farmer groups or seed banks, this system currently focuses food crops like rice and legumes and engages with the formal system to introduce new superior varieties, ensuring some sort of certification;
- The system that currently receives most attention is the public seed system. Here, the main crop is rice, with a share of more than 90% of all certified seed. In this system the DAR and DoA Seed Farms are responsible for breeder seed, foundation seed and registered seed production, whereas most of the certified seed production takes place by contact farmers (the latter organized in seed villages);
- The public-private system is comparable to the public system, but focuses on seed companies for the last two multiplication steps (registered seed and certified seed). Also here rice is the main crop, though also some activities are starting up in the field of potatoes and maize;
- Lastly, the private seed system focuses on (hybrid) vegetables and fruits, hybrid maize and rice. The system is dominated by a few larger seed companies that produce and sell seed of their own (registered) varieties. The seed sales run through their own system of agents and/or through the more than 3.000 agro-dealer shops.

### **A Research and Seed Farm System that could benefit millions of farmers**

Though widely criticized the DAR and DoA Seed Farms perform a crucial element in the seed-chain, availing new technologies to farmers and fulfilling an important function for food security objectives. Especially, for food crops and crops that are less commercially interesting (non-hybrid rice, legumes, oilseeds, and roots and tubers) there will remain a *raison d'être* for the seed farms. It is important to note in this respect that African countries that privatized this system almost always ended up with a few companies only working on hybrid maize neglecting all other crops and varieties (i.e. Uganda, Malawi, and Kenya). Also, our calculations show that with the existing seed prices and at average crop yields, the investigated seed farms could be operated on a cost-recovery or profit basis.

Overall, a rationalization in focus and incentives for the seed farms seems necessary. There are a number of seed farms that enjoy excellent conditions for becoming financially self-sustainable and entrepreneurial (public-private) enterprises. The study proposes that a number of seed farms are allowed a more semi-autonomous status. Semi-autonomous implying that: revenues from seed production flow back to the operations of the seed farm (and hence can cover for investments); that they have the freedom (within certain boundaries) to decide on which crops and varieties to grow and how to market them; and that they are encouraged to engage in arrangements with private sector parties (as investors, out growers and/or salesmen). It is expected that the increased freedom will: increase the diversity in varieties produced; enhance the quality of the foundation or registered seed; boost the overall quantities produced; and encourage more collaboration with certified seed producers. For the more commercially interesting crops (rice, maize, sunflower) the latter collaboration can be with seed companies, while for other crops (legumes, oilseeds, roots and tubers) more extended collaboration can be sought with farmer groups and the system of contact farmers. In the end, the rationalization can also stimulate competition between Seed Farms and favour the best managed and market-oriented farms. Probably the number of seed farms can eventually be reduced in this way, as the current number and total acreage is relatively high (e.g. the combined DoA Seed Farms cover an area of 5,600 hectares<sup>3</sup>).

### **Great business opportunities though some challenges remain**

For crops like hybrid rice, hybrid maize, (hybrid) vegetables and ornamental seeds, and to a lesser extent seed potatoes there are very good business opportunities for seed production and sales in Myanmar. Currently, the number of active domestic and foreign seed companies is low, while all of them indicate that Myanmar has excellent conditions for producing seed.

<sup>3</sup> 5,600 hectares could produce around 17,000 tons of registered rice seed, which could be multiplied to 1.3 million tons of certified rice seed, which could be used on more than 30 million hectares of land; which in turn is almost 3 times the currently cultivated area of Myanmar (adapted from DoA, 2013; estimated yield: 3 tons/ha, seed rate: 40 kg/ha; multiplication factor: 75).

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Often output markets trigger the input markets. When demand and prices for key commodities increase the input markets of seeds, fertilizer and crop protection often react immediately. Given the strong yearly growth in both GDP and agricultural value, it can be assumed that there will be an increased demand for quality seeds. The current business models of successful companies, however, show that, given the low level of knowledge on improved inputs, a more comprehensive approach to seed sales is necessary. Most of the successful companies, therefore, also invest in their own farm extension, marketing network and sometimes credit.

There remains a number of challenges for international companies to invest in Myanmar's seed sector. In particular the fact that you cannot fully own a foreign company and the lack of Plant Variety Protection currently limits fully fledged foreign operations (including foundation seed production and having own sales points). In addition, companies mention that the functioning of the banking sector is still poor, and that procedures for starting a company and registering varieties are unclear and lengthy.

### **A clear need for greater Seed Sector Governance and Seed Chain Coordination**

Some related institutional bottlenecks were mentioned, in particular the 'silo mentality' of the different government institutions and divisions. The limited communication and collaboration between DAR, the DoA Seed Division and DoA's Extension Division leads to inefficiencies in the performance of the seed chain and quality assurance system. In turn, this reduces the number of in-demand varieties reaching farmers and the overall seed quality.

With respect to the quality assurance system major limitations were observed in field inspections and seed testing. The limitations cut across all the levels, from the DAR Seed Farms to the DoA Seed Farm and from the Seed Villages to the Seed Testing Laboratories. The bottom line is that there is a lot of emphasis on the quantity of seed produced but less so on quality.

The draft Seed Policy clearly acknowledges these challenges and proposes a number of solutions:

- The development and implementation of the new Seed Law and Regulations;
- Providing incentive schemes to the private sector;
- Better coordination of the seed chain through setting up a well-capacitated office for the National Seed Committee; and
- The establishment of a semi-autonomous Seed Certification Unit.

The latter will bring together the seed laboratories, field inspectors and will also have the responsibility for Variety Registration (MoAI); as such bringing together specific tasks from DAR and DoA's Seed Division. The SCU will be allowed to charge appropriate fees for its services, such as variety registration, seed testing and certification.

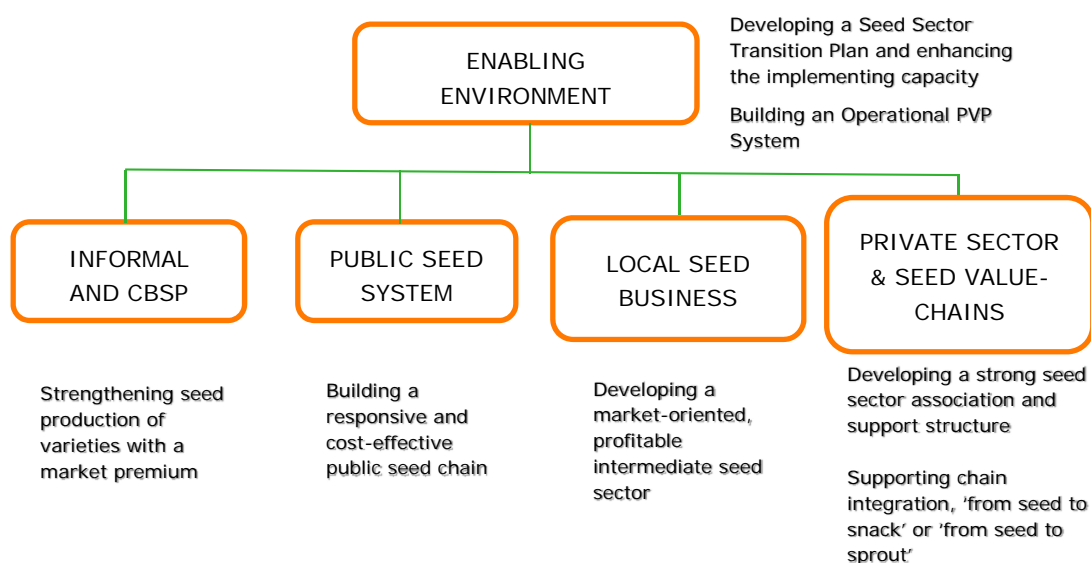
Implementing these policy ambitions and possible other reforms (like the seed farm and PVP systems) will require a strong guidance and consistent approach by the government. To this end the National Seed Committee can play a crucial role, though its representation is limited to the public sector (see annex 3). Hence, a broader stakeholder dialogue is recommended that can guide the institutional changes necessary for increasing the availability of affordable seed of superior varieties. The dialogue could result in a jointly endorsed transition plan that gives hand and feet to the mentioned challenges and policy objectives.





## 8 Proposed activities to unlock Myanmar's seed sector potential

The ISSD approach is helpful in comprehensively bringing together all these issues in one integrated framework, taking into account the diversity in cropping systems and levels of commercialization; as well as the institutional setting and capacities on the ground. Figure 5 shows the different seed systems of Myanmar; it lists the issues and potential activities that address the systemic issues and proposes concrete improvements. The overall objective of the integrated program would be: 'to enhance farmers' access to quality seed of superior varieties, and contribute to food security and economic development'.



**Figure 5:** Pathways and projects for of integrated seed sector development in Myanmar

### 8.1 Enabling environment

#### **Developing a Seed Sector Transition Plan and enhancing the implementing capacity**

The draft Seed Policy clearly acknowledges the sector's challenges and proposes a number of solutions:

- The development and implementation of the new Seed Law and Regulations;
- Providing incentive schemes to the private sector;
- Better coordination of the seed chain through setting up a well-capacitated office for the National Seed Committee;
- The establishment of a semi-autonomous Seed Certification Unit.

All these changes require more detailed implementation strategies and operational plans. To ensure the coherence in the implementation of the Seed Policy the development of a Seed Sector Transition Plan is suggested. The Transition Plan can provide the guidance for the establishment of new and transformation of existing government organizations, like the National Seed Committee, the Seed Certification Unit, and Seed Farms.

Subsequently these organizations require institutional strengthening. Most impact is expected from a well-capacitated National Seed Committee that can coordinate the seed chain (from breeder's seed to foundation seed, and from registered seed to certified seed) in terms of: varieties, quantities produced and appropriate quality assurance systems. Furthermore, the NSC can provide guidance in terms of

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PVR Guidelines, the establishment of the SCU, reforms in the Seed Farm system, and the operationalization of the PVP Law. Secondly, the proposed Seed Certification Unit will require assistance in terms of the training of field inspectors, seed testing laboratory staff, some hardware for the operations and clear procedures for executing the PVR trials.

Currently, the voice of the private sector is not heard much in the policy development process. When the private sector meets with the government it is often on an individual basis, discussing immediate issues or plans. A more organized voice of the private seed sector can help improving the public-private dialogue and hence, informing the public sector on alternative policy directions and enforcement options. To this end, the establishment of a National Seed Association has been proposed (Round Table on Horticulture, 20-11-2014). The Association brings together Myanmar's main seed companies (both domestic and foreign) and provides services to its members as well as discuss with government on seed sector challenges and opportunities.

### **Building an operational PVP system**

A draft PVP Law has been in development since 2010. It is expected that the law will pass Parliament in the course of 2015, which will allow for the protection of new varieties developed both in the public and private system. After the approval of the Law, Myanmar will need to set up a national PVP decision making body (or assign its tasks to the NSC) and an Office of the Registrar; as well as develop PVP rules and testing guidelines (for Novelty, Distinctness, Uniformity and Stability) to ensure effective implementation. In addition, some guidelines can be developed for the DAR's Research Centres and the Universities (as being public organisations) on how Plant Breeders' Rights can increase incentives for research staff. Lastly, the judiciary will need to understand the implications of the PVP Law in case conflicts arise between breeders, seed companies and/or farmers. All this requires an integrated intervention that: involves key concerned parties (public, private and NGOs) in the formulation process; and that addresses the capacity needs of DoA's Seed Division, DAR and the seed companies. A well-functioning PVP System will greatly enhance the trust of international companies to invest in Myanmar's seed sector, as well as provide incentives to the domestic research system to valorise new varieties.

## **8.2 Informal seed system**

The informal seed system will remain playing a dominant role in Myanmar's seed sector. It is estimated that currently the informal system contributes more than 95% of all rice seed planted in Myanmar, and for most other crops this percentage is higher (except for vegetable and maize seeds). Clear opportunities exist to strengthen the informal sector and to create linkages with the formal seed system. As such the rice sector holds the greatest opportunity for selecting and introducing new, high quality varieties and improving local seed quality.

### **Strengthening local rice seed production of premium varieties**

Specific aromatic rice varieties (often combined under the name Posamwe) have a high demand in Myanmar's food market. Superior varieties travel long distances from their place of origin (e.g. Shwebo) to the farmer's field. Especially, in the Southern delta areas these varieties are popular while the availability of good quality seed is low. Already some activities in the LIFT program are supporting farmers to better select new varieties (e.g. through Participatory Variety Selection) and support livelihoods in better seed management practices and developing local seed markets. There is growing consensus that rice exports need to be diversified to include different qualities of rice, which will allow rice farmers to earn higher incomes, and diversify risks along different markets (WB, 2014). The first lessons learned in the LIFT program (Delta Area) could be scaled out to a larger number of seed producing groups and associations, focusing on increasing the availability of high-quality rice varieties and enhancing farmers' capacities to maintain and store good quality seed. In addition, these activities can also contribute to conserving and using the agrobiodiversity, which will be necessary for the continuous adaptation to climate change. E.g. Myanmar's current diversity in rice varieties (including landraces) includes traits that are less susceptible to droughts, floods and salinity.

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## 8.3 Public seed system

The system of Research, Seed Farms and out grower models is often a prerequisite for promoting and disseminating new varieties and quality seed to farmers, for a wide range of crops. Though the system suffers from a number of limitations, it does create a good starting point for seed sector growth.

### **Building a responsive and cost-effective public seed chain**

A number of challenges in the public seed system require more systemic change, e.g. the coordination mechanisms between DAR, DoA's Seed Division and DoA's Seed Extension. Already solutions to this are provided in the Seed Policy. Once a number of institutional issues have been addressed, the next step will be to increase the responsiveness and market-orientation of the Seed Farms.

Overall, a rationalization in focus and incentives for the seed farms seems necessary. There are a number of seed farms that enjoy excellent conditions for becoming financially self-sustainable. The study proposes that a number of these seed farms are allowed a more semi-autonomous status and are supported to become more entrepreneurial and market-oriented. The recommendation can be operationalized by selecting e.g. four very different seed farms as pilots for which private sector collaboration is solicited (with the aim of establishing a public-private joint venture). Within the new business model key crops and varieties can be selected that are in-demand by the surrounding farmers and for which – when necessary – out grower or farmer group models can be developed.

## 8.4 Local seed business

The last step of multiplication (to certified seed) is the one where serious hiccups take place, both in the quality and quantities produced. The systems has been organized around domestic seed companies, out growers and the Seed Village scheme. Issues here include the earlier mentioned constraints at the Seed Farms and the 'silo mentality' of the different institutions responsible for seed production and quality control. Still, the system holds great potential, given the relative profitable price setting (examples provided for registered rice seed production in the seed value-chain chapter), the 'open' marketing system (farmer to farmer, shops and value-chains) and the supportive role of the Township Administrations. In addition, Myanmar has a number of production areas that are perfectly suited for seed production: in particular Southern Shan and the Dry Zones of Magway and Mandalay. The main challenge is how to develop a market-oriented system with sufficient incentives for everyone involved in the chain.

### **Developing a market-oriented, profitable intermediate seed sector**

The current actors involved in certified seed production are rather fragmented. Especially the concept of Seed Villages requires rethinking. For effective seed production a certain level of organization and scale is necessary: i.e. an organization that can ensure adequate (internal) quality control and business planning, and scale to reduce the costs for the investments (storage, cleaning) and transactions. Given the limitations in the Association Law (currently under revision) the number of farmer groups in Myanmar is limited. It was observed that this gap is filled by a number of larger farmers and small and medium sized domestic seed companies (especially for rice). There is potential for transforming the Seed Village scheme from a rather 'production push' orientation to a more entrepreneurial 'market pull' direction. This direction could lead to farmer based local seed businesses either registered as an association or company (with shareholders).

In particular, opportunities exist for legumes and oilseeds crops, as well as the staples, rice and potatoes. In other countries (Ethiopia, Nepal, Uganda) much experience has been gained with this approach, supporting farmer groups in their seed entrepreneurship, quality seed production skills, organizational capacity and strategic linkage (with e.g. banks and research). Completely self-sustainable, innovative Local Seed Businesses have emerged in these countries that in the case of Ethiopia provide more than 10% of all certified seed of *teff*, legumes, oilseeds and potatoes.

In Myanmar, a pilot could be started to see if the concept is applicable, focusing on relatively stronger, existing farmer groups and small seed enterprises first. Probably priority crops and areas would be the Dry Zone (legumes and oilseeds) and Shan State (for potato). These crops are especially suitable for

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testing the approach, as they are difficult crops for commercial seed production. This is due to the fact that they can be easily reproduced by farmers themselves (self-pollinating or vegetatively propagated), and have a low multiplication rate (around 10 for potatoes, and 40 for green/black gram). An envisaged activity aims at testing the LSB business case for Myanmar ('proof of concept').

## 8.5 Private sector and commercial seed value-chains

The number of domestic and foreign seed companies in Myanmar is relatively low. Many companies are sitting on the fence, waiting for the business climate to improve. At the same time they indicate that Myanmar has excellent conditions for producing seed. East-West's Group Seeds Operation Manager of East West Seeds, Mr. Michel Devarrewaere, recently said that: "I cannot dream of a better place than Myanmar [and in particular the Dry Zone] to produce seed". A number of other companies are not yet aware of the business opportunities in Myanmar. So, some hands-on support to both domestic and foreign seed companies, including B2B linkage and detailed information on the investment and seed regulations, could give them just that extra push to invest. Specifically for Dutch companies there are opportunities in the production and sales of vegetable seeds, ornamental flower seeds and seed potatoes. Myanmar's farmers and economy can benefit by increasing the availability of better seeds of new varieties as well as through an increase in foreign direct investment.

The second opportunity for the private sector is in the development of commercial seed-crop value-chains. Currently these are limited to (hybrid) vegetable seeds, hybrid maize, hybrid sunflower and hybrid rice. Still this system also holds a promise for non-hybridized crops, like potato (because of the high prevalence of seed borne diseases) and possibly green gram and brewing rice for very specific market outlets (EU mungbean market and the brewing industry). Some successful examples exist in Myanmar, where seed companies not only sell seed but also support farmers in the entire process of crop production (e.g. CP hybrid maize production, Myanmar's Rice Federation's seed production scheme, and East-West's extension support program). Key ingredients for these success stories are: a long-term vision, the combination of superior inputs with technical assistance and pre-finance. In one case even a target yield was guaranteed and an agrochemical package provided. The examples could be adapted and replicated for other crops as well.

### **Developing a strong seed sector association and support structure**

Both domestic and foreign companies are currently not very well represented in the national dialogue on seed sector reform. For example, in preparing the Seed Policy and PVP Law the private sector was hardly consulted. Also, there are currently no mechanisms that can channel the feedback of the private sector on the implementation of specific regulations (on variety release, or the agro dealer trainings). From a government point of view it has been difficult to solicit the advice of the private sector, as it is fragmented and poorly organized. To this end, the Round Table on Horticulture (20/11/2014, Nay Phi Taw) has recommended the establishment of a Seed Sector Association. The Association will have the task to represent all private seed companies in Myanmar and advise the government on all policy and enforcement issues. In addition, the Association (e.g. through its secretariat) could also support new seed companies with investment information, matchmaking and useful networks. As doing business in Myanmar is not easy, sector specific support for potential investors is highly welcome. For Dutch companies in specific, opportunities exist in the production and sales of vegetable and ornamental flower seeds, as well as seed potatoes.

### **Supporting chain integration, 'from seed to snack' or 'from seed to sprout'**

The potato value-chain is currently plagued by infected planting material and widespread presence of diseases in the farming systems (bacterial wilt and late blight). Though initiatives are in place that support potato seed production in the public system (examples provided in the seed potato value-chain chapter), there also seems to be a commercially viable business case for engaging seed potato companies. Already interest has been expressed by a number of foreign companies, both from the input supply sector as well as from the potato processing industry. These parties understand that selling seed potatoes or buying ware potatoes alone, is not enough to develop a sustainable market. They also plan to provide an integrated input package (agrochemicals) with some level of technical assistance and pre-finance. Some additional support could be provided for these initiatives, specifically

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focussing on capacity building for smallholder farmers, local seed potato production (instead of imports) and developing sustainable credit systems.

A similar promising business case is in place for the export mung bean chain. In the farming systems of the Southern Delta as well as the Dry Zone, mungbean is often the most important cash crop. The profitability of the crop outweighs rice production and there is a ready (though volatile) export market. Recent food safety related incidences, however, have prompted a need for a system change. A system change from spot market production to value-chain development, with seed as a potentially important driver. Developing an integrated chain could kill three birds with one stone: increased productivity, enhanced quality of supply (purity and grain size), as well as improved food safety standards; hence, making it an alluring business case for farmers, input suppliers and exporters. A pilot activity is envisaged that brings together a seed company, a group of farmers and an exporter, that jointly develop the export chain – bringing in improved varieties of mungbean seed. In time, seed production of the most successful varieties can be initiated; though this probably requires stricter variety protection for the seed company.

### 8.6 Overview of activities

The following table summarizes the proposed activities and envisaged outcomes. This is a tentative list of examples of how critical bottlenecks can be tackled by concrete solutions and activities. In addition, the table provides information on the crop and regional focus, potential partners and funding opportunities. All activities combined can be taken as a full-fledged Integrated Seed Sector Development program.

Table 18: Overview of envisaged ISSD program activities in Myanmar

Project	Problem analysis	Proposed Solutions and Activities	Envisaged outcomes	Crops and Regional Focus	Main Partner(s)	Potential funder
1. Seed Sector Governance	Lack of seed sector coordination Low quality seed Opaque PVR procedures	Developing a public-private platform for dialogue and guidance on seed sector development Developing a Seed Sector Transition Plan Strengthening the Office that supports the National Seed Committee Developing and capacitating the semi-autonomous Seed Certification Unit Assisting in developing guidelines and procedures for Plant Variety Release	Dialogue between seed sector stakeholders leading to broadly supported transition plan Well-capacitated, effective seed sector institutions Clear and transparent regulations and procedures More private sector investments in the seed sector	All crops and all States and Divisions	DoA-Seed Division, NSC, NSA, WUR, NAK	Netherlands (PSD Apps / K2K) FAO
2. Plant Variety Protection	Absence of an operational plant variety protection system	Supporting the finalization of the Plant Breeders' Rights Law Capacitating DAR, the Office of the Registrar, and the Judiciary	A well-functioning PVP system that provides sufficient guarantees for companies that want to invest, and incentives for public researchers to develop new varieties	Commercial crops and all States and Divisions	DAR, Office of the Registrar, Judiciary, Private Sector Association, NAK, WUR	Netherlands (PSD Apps / G2G)
3. Informal rice seed systems	Lack of quality, rice seed of superior varieties	Conservation and use of rice plant genetic resources Participatory Variety Selection of a wide range of superior quality rice varieties Developing sustainable, local quality seed production systems and developing local seed markets	Increased availability of quality seed of superior varieties Increased resilience (incl. climate adaptation) Higher farm income (improved gross margin) both of seed producers and users	(Initially) Rice in Delta Region (Yangon, Ayeyarwady and Rakhine)	NGOs, IRRI, WUR	LIFT (Call for Proposals for Delta Zone, late spring 2015)
4. Seed Farm reform for field crops	Insufficient early generation seed of in-demand crops and varieties	Support DoA under the Seed Sector Transition Plan to reform the Seed Farms, piloting with a few new arrangements that focus on self-sustainability and market orientation	More and better quality early generation seed available for in-demand varieties	Pilot with four seed farms (to be selected)	DAR, DoA, private sector, WUR	ADB, FAO (?)

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5. Proof of Concept: LSBs & SSEs in Myanmar – (a) Legumes and Oilseeds; and (b) Potatoes	Lack of quality seed of superior varieties of legumes, oilseeds and potatoes	Support farmer groups and small-scale seed enterprises in seed production and marketing: entrepreneurship, quality seed production and business skills, organizational capacity and strategic linkage	Increased availability of quality seed of superior varieties Higher farm income (improved gross margin) for both seed producers and users	(Initially) legumes and oilseeds in the Central Dry Zone (Sagaing, Magway and Mandalay) and potato in Shan State	NGOs, DAR/ DoA Seed Farms, SAI/ Yezin University , WUR	LIFT (Call for Proposals for Dry Zone, Dec14-Jan15 and Shan State, spring 2015). Netherlands (potato)
6. Support to domestic and foreign seed companies	Limited presence of reputed seed companies, both in seed production and sales	Support foreign companies to invest in Myanmar with investment information, matchmaking and networks Establishing a National Seed Association (NSA)	Increased availability of improved varieties More private sector investments in the seed sector	Countrywide private investments	MoAI, NL Mission in Yangon, Seed companies	Netherlands – Ministry of Economic Affairs
7. Commercial seed value-chains	Lack of improved varieties and specialized agricultural production skills for high end markets	Support to farmers (in contract farming arrangements) on crop production and postharvest management	Increased availability of improved varieties Higher farm income (improved gross margin) Increased FDI and exports	(Initially) Mungbean, and vegetables and potato in resp. Yangon Division and Shan State	Seed companies, exporters, processors and farmers, WUR	LIFT (Call for Proposals, Private Sector window)

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# Appendix 1 Interviewed seed sector professional

- Mr. Stuart Morris and U Thein Tun, resp. Agricultural Extension Manager and Product Manager, East-West Seed International Limited, Yangon
- Dr. Khin Thida Myint and Dr. Cho Cho San, resp. Professor and Head of the Department of Horticulture and Professor and Head of the Department of Agricultural Economics, Yezin Agricultural University, Yezin
- Daw Tin Tin Myint and Daw Than Than Nu, resp. Rice Division Director and Horticulture Research Officer, Department of Agricultural Research (DAR), Nay Pyi Taw
- U Naing Kyi Win, Deputy Director General, Department of Agriculture (DoA), Nay Pyi Taw
- Dr. Tin Htut, Director General, Department of Agricultural Planning (DAP), Nay Pyi Taw
- U Ko Oo, Farm Manager, Individual private seed farm (out grower for Know You vegetable seeds), Kyauk Chat village, Nay Pyi Taw
- U Thar Htun, Farm Manager, Research and Seed Production Farm, Department of Agricultural Research (DAR)
- U Nyi Nyi Aung, Farm Manager Hlaing Det Farm, Department of Agriculture (DoA), Hlaing Det, Tharzi township, Mandalay Region
- U Zaw Myat Htun, Township Extension Officer, Pindaya township, Department of Agriculture (DoA), Pindaya township, Shan State (South)
- U Kyaw Zaw, Lead Contract Farming for CP Company, Tante village, Shwe Nyaung township, Shan State (South)
- Daw Zin Nwe Win, Assistant Staff Officer, Heho Seed Multiplication Farm, Department of Agriculture (DoA), Heho Township, Shan State (South)
- Daw San San Aye, Daw Me Me Cho and Daw Chin Thin Tront, resp. laboratory head, assistant director and staff officer at the Seed Quality Control Laboratory, Gyogone, Yangon
- Dr. Ohnmar Khaing, Coordinator, Food Security Working Group, Yangon
- Mr. Curtis Slover, Program Officer (Rural Finance & Value-chains), Livelihoods and Food Security Trust Fund, Yangon
- Mr. Antoine Deligne, Livelihoods and Food Security Specialist, Livelihoods and Food Security Trust Fund, Yangon
- U Nay Myo, Agricultural & Livestock Officer, Livelihoods and Food Security Trust Fund, Yangon
- U Aye Tun, Deputy Director General, Department of Agriculture (DoA), Nay Pyi Taw
- U Thura Soe, Deputy Director (Seed Division), Department of Agriculture (DoA), Nay Pyi Taw
- Dr. Ye Tint Htun, Acting Director General, Department of Agricultural Research (DAR), Nay Pyi Taw
- U Win Soe, Research Assistant, Nyaung Oo Farm (DAR), Nyaung Oo Township, Mandalay Region
- Mr. Masaru Yamada, Project Coordinator, The Project for Development of Water Saving Agriculture Technology in the Central Dry Zone, JICA, Nyaung Oo Township, Mandalay Region
- Mitsuo Matsumoto, Chief Advisor, The Project for Development of Water Saving Agriculture Technology in the Central Dry Zone, JICA, Nyaung Oo Township, Mandalay Region
- Daw Kyi Kyi Swe, Staff Officer (Seed), Nyaung Oo District, Mandalay Region
- Daw Tin Cho Aye, Zonal Monitoring Coordinator, World Vision International Myanmar, Mandalay
- U Than Tun, Farm Manager, Kyetmauktaung Farm (DoA), Kyaukpadaung township, Mandalay Region
- U Win Myint, Village Administrator, Kine Village Tract, Kyaukpadaung township, Mandalay Region
- U Thaug Kyi, Farmer, Kine Village (Seed Village), Kyaukpadaung township, Mandalay Region
- U Moe Thee, Farmer, Kine Village (Seed Village), Kyaukpadaung township, Mandalay Region
- U Ye Maung, Farmer, Inn Daw Village (Seed Bank), Kyaukpadaung township, Mandalay Region
- U Thein Htay Oo, Farm Manager, Magway Farm (DAR), Magway township, Magway Region
- U Myo Htay, Farmer, Magyikan Village (Farmer Seed Bank), Magway township, Magway Region
- U Kyaw Thi Ha, Farm Manager, Pwint Phyu Farm (DoA), Pwint Phyu township, Magway Region
- U Pho Par, Farmer, San Pya Village (Seed Village), Pwint Phyu township, Magway Region
- Daw Moe Thanda Htwe, Farmer, Kan Thar Gyi Village, Pwint Phyu township, Magway Region



## Appendix 2 Variety list

### Crop Name: Paddy

Sr. No	Variety name	Line No./Original Name	Released year
1.	Shwe Wah Htun	IR-5 Mutant	1974
2.	Shwe Ta Sote	Local	1979-80
3.	Si Lay	C4 – 63	1970
4.	Sein Ta Lay	X69-2-27	1975
5.	Shwe Wah Yin	IR-24	1973
6.	Shwe Wah Lay	IR-28	1981
7.	Sin Theingi	BR-51-91-6	1978
8.	Sin Thiri	BG-90-2	1978
9.	Ngway Toe	C 53-39	1953
10.	Shwe Thwe Lay	IR 751-592	1979
11.	Ayar Min	Machando	1977
12.	Hmawbi-1	IR 42	1984
13.	Hmawbi-2	IR 21836-90-3	1985
14.	Sin Shwe Thwe	IR-34	1981
15.	Manaw Hari	Mahsuri	1974
16.	Manaw Thukha	Mahsuri (M)	1978
17.	Shwe Thwe Htun	IR-24 m4-17	1980
18.	Kyaw Zeya	X70-18-32 (Yarkyaw-2 x Aung Zeya)	1980
19.	Pale Thwe	Pelita 1-1	1979
20.	Sin Akri-1	X72-8-22 (Shwe Wah Yin x Kauk Hmwe)	1984
21.	Lone Thwe Hmwe	KDML-105	1986
22.	Ye Baw Yin	Local	-
23.	Ye Baw Latt	Local	-
24.	Ye Baw Sein	A 52-21, Local	1952
25.	Ye Baw Yoe Sein	Local	-
26.	Inn Ma Ye Baw	Local	-
27.	Ehma Hta Amagyi	A 28-8	1928
28.	Shwe Din Gar	A 56-11	1956
29.	Hnan Wah Mee Kauk	A 36-3	1936
30.	Pin Toe Sein	A 29-20	1929
31.	Hmaw Nga Sein	A 15-10	1915
32.	Man Nga Sein	C 40-1	1940
33.	Shwe Shay Kyin	C 33-18	1933
34.	Shan Nyein	C 24-47	1924
35.	Hnan Kar	B 57-7	1957
36.	Mee Kauk	B69-1	1969
37.	Paw Sann Hmwe	D 44-8	1944
38.	Paw Sann Bay Kyar	D 60-8	1960
39.	Nga Kywe	D 25-4	1925
40.	Nga Kywe Taung Pyan	-	-
41.	Thee Htat-1	X 72-7-1	1985
42.	Thee Htat-2	X 72-7-10	1985
43.	Thee Htat-3	X 72-7-15	1985
44.	Yay Nak-1	BKN-6986-108-3 (Thailand)	1976
45.	Yay Nak-2	BKN-6986-167 (Thailand)	1976
46.	Yay Nak-3	RD-17 (Thailand)	1983
47.	Yay Nak-4	X 73-20-19 (C4-63-Nga Kywe Phyu)	1983
48.	Yay Nak-5	BH-2 (Africa, Ceyarliyun country)	1984
49.	Yay Nak-6	RD-19 (Thailand)	1985
50.	Yay Nak-7	B-922-CMR-118 (Indonesia)	1985
51.	Maykhalar-1	BKN-6986-51-1 (Thailand)	1980
52.	Maykhalar-2	BKN-6986-59-12 (Thailand)	1980
53.	Maykhalar-3	BKN-6986-30-1 (Thailand)	1980
54.	Maykhalar-4	BKN-6986-108-2 (Thailand)	1980
55.	Maykhalar-5	BKN-6986-66-2 (Thailand)	1980
56.	Yezin Yar-1	C-22 (Philippine)	1976
57.	Yezin Yar-2	KN-96 (Indonesia)	1977
58.	Yezin Yar-3	KN-117 (Indonesia)	1977
59.	Yezin Yar-4	LG-240 (Philippine)	1977
60.	Yezin Yar-5	IR-1529-680-3	1984
61.	Yezin Yar-6	YN-91-45 (C-22-IR-2035)	1984

62.	Yezin Yar-7	YN-92-7 (C-22-IR-2153)	1985
63.	Sar Ngan Khan-1	X73-3-9 (Shwe Wah Yin-Lone Ni)	1985
64.	Sar Ngan Khan-2	X 73-3-18 (Shwe Wah Yin-Lone Ni)	1985
65.	Sar Ngan Khan-3	X73-12-8 (C4-63-Yaythuma)	1985
66.	Sin Shwe Po-1	IR 72	-
67.	Sin Shwe Po-2	Aster Nak Gaw Yee	-
68.	Hybrid rice-6201	-	2001
69.	Hybrid rice-6207	-	2001
70.	Hmawbi-3	MR-219	2003
71.	Hmawbi-4	Q-50	2003
72.	Oakthar Hmwe	Royal Thai Rice	2003
73.	Shwe Myanmar	RP-1674-690-39-14	2001
74.	Thukha Yin	MNTK M4-10 (Manawthukha Htun)	2001
75.	Yezin Lone Thwe	LTH M4-14 (Lone Thwe Hmwe Htun)	2001
76.	Shwe Pyi Tan	PSBR C-68	2002
77.	Yar-2 Htun	H -18	1999
78.	Sin Thwe Latt	IR-53936-60-3-2-3-1	2003
79.	Hmawbi-5	6201-R	2006
80.	Hmawbi Kauk Hnyin Hmwe	CNS-1	2009
81.	Pakhan Shwe Wah	PSC RC-18 (51672-62-2-1-1-2-2-3)	2004
82.	Sin Thukha	IR Yn1068-7-1	2007
83.	Yadanar Toe	Thai-1-9-3 E	2008
84.	Sin Nwe Yin	Yn 2883-12-2-1	2008
85.	Shwe Pyi Htay	Yn 2841-B-1- UL 26	2008
86.	Shwe Manaw	Taminadu	2005
87.	Shwe Padaytha	Xiang Zao Xian 19	2007
88.	Yay Anelo-1	IR 55423-01	2008
89.	Pyi Lone Hmwe	Supharburi-1 (SPRLP85163-5-1-1-2)	2007
90.	H-6444 (Hybrid rice)	930214201	2006
91.	Dhani 07002 (Hybrid rice)	930215210	2007
92.	Pale Thwe-1 (Hybrid rice)	-	2013
93.	Hmawbi-6	IR 13240-108-2-2-3 (Mutant)	2010
94.	Hmawbi-7	IR 13240-108-2-2-3 (Mutant)	2010
95.	Myaung Mya May	PRAM BEI KOUR	2011
96.	Yay Myoke Khan-1	Swarna-sub 1	2011
97.	Sar Ngan Khan Sin Thwe Latt	Yn 3220-MAS-62-2-4	2011
98.	Yay Anelo-2	UPLRI-7	2011
99.	Thukha Hmwe	Yn 3248-BC <sub>4</sub> F <sub>2</sub> -33	2011
100.	Akari Hmwe	IR 78525-150-1-3-1	2011
101.	Pale Thwe-4 (SL-8H-ISMSA) (Hybrid rice)	-	2011
102.	Dagon-1 (IR-123)	PSB-RC-82	2012
103.	Dagon-2 (IR-421)	IR-75581-12-3-2-2	2012
104.	Dagon-3 (IR-150)	IR-30AA-433) A-2258	2012
105.	Thiri Thukha	RMNTK-1-UL 16	2006
106.	Yay Anelo-3	WAB-880-SG-6	2005
107.	Shwe Pyi Hmwe	IR 66233-151-1	2013
108.	Ayar Hmwe	1268	2014
109.	Shwe Toe Lay	IAC/P 001 PAC 807	2013
110.	Shwe Moe Lay	IAC/P003 PAC 835	2013
111.	Shwe Toe Gyi	IAC/P004 PAC 837	2013

#### Crop Name: Wheat

Sr.No	Variety name	Line No./Original Name	Released year
1.	Yezin-1	LYP-73	-
2.	Yezin-2	SA-75	-
3.	Yezin-3	V-1287	-
4.	Yezin-4	LU-26	-
5.	Yezin-5	BLUE-Silver	-
6.	Zalote Phyu-1	-	1997
7.	Zalote Phyu-2	-	1997
8.	Zalote Phyu-4	-	2004
9.	Yezin-8	26 <sup>th</sup> ESWYT-12	2012
10.	Yezin-9	28 <sup>th</sup> ESWYT-41	2012
11.	Yezin-10	28 <sup>th</sup> ESWYT-48	2012

#### Crop Name: Maize

Sr.No	Variety name	Line No./Original Name	Released year
1.	Shwe Wah-1	Lacalera (1) 7728	-
2.	Shwe Wah-2	Peiralira-7736	-
3.	Shwe Wah-3	Satipo (1)-7627	-

4.	Shwe Wah-4	Indonesian-Early	-
5.	Shwe Wah-5	Tc(1)Medok	-
6.	Shwe Wah-6	Islamabad-8131	-
7.	Shwe Wah-7	TL-7322	-
8.	Shwe Wah-8	Across-7835	-
9.	Shwe Wah-9-	Suwan-1	-
10.	Shwe Wah Phu	Pachung-1602	-
11.	Akari	Suwan-1	-
12.	Yezin Hybrid-3	Line 18 x Line 82	2001
13.	Yezin Hybrid-4	-	2001
14.	Yezin Hybrid-5	18-9701	2000
15.	CP-888 (Hybrid)	CP-888 (Hybrid)	2000
16.	Yezin Hybrid-6	-	2007
17.	CP-989	-	2007
18.	CP-301	-	2012
19.	CP-801	-	2012
20.	T.P ONE	JK-26210	2012
21.	Yezin Hybrid-10	-	2011
22.	Yezin Hybrid-11	-	2011
23.	CP 111	CP 111	2013
24.	CP 201	CP 201	2013
25.	CP888 3 G	CP 888 3G	2013
26.	JD 8	U.H-008	2014
27.	VN 101	LVN-10	2010

#### Crop Name: Sweet Corn

Sr.No	Variety name	Line No./Original Name	Released year
1.	Sugar King 6090	Sugar King	2013
2.	Sugar Queen	Sugar Queen	2013
3.	Golden Cob-806	Golden Cob-806	2013
4.	New 75	ABP(S)SC 75	2013
5.	Golden Sweet	ABP(P) HB 3	2013
6.	Double Gold	ABP(P) HB 53	2013
7.	Fancy Mix	ABP(P) FC 21	2013
8.	Sticky White	ABP(P) MX 1	2013
9.	Colour Sticky	ABP(S) Waxy Colour	2013

#### Crop Name: Sorghum

Sr.No	Variety name	Line No./Original Name	Released year
1.	Shwe Ni-1	IS-8965	-
2.	Shwe Ni-2	IS-2940	-
3.	Shwe Ni-3	CS-99	-
4.	Shwe Ni-4	UPLB-SG-5	-
5.	Shwe Ni-5	D-67-4	-
6.	Shwe Ni-6	C 5 - 102	-
7.	Shwe Ni-11	C 5 - 105	-
8.	Shwe Ni-14	490003	-
9.	Yezin Hnansar Pyaung Phuu-1	M-90906	1984
10.	Yezin Hnansar Pyaung Phuu-2	M-36248	1984
11.	Yezin Hnansar Pyaung Phuu-3	M-3635	1984
12.	Mahlaing San Pyaung	-	-
13.	Yezin Pyaung Cho-1	-	2011

#### Crop Name: Groundnut

Sr.No	Variety name	Line No./Original Name	Released year
1.	Sin Padaytha-1	M-28	1980
2.	Sin Padaytha-2	JL-24	1982
3.	Sin Padaytha-3	ROBOT-31-1	-
4.	Magway Pinpyant-2	C-148-2	-
5.	Magway-9	Sp-121	-
6.	Magway-10	SP121-070 x SS50/50	-
7.	Magway-11	Schwartz-21/6	-
8.	Magway-12	Tainan-9	-
9.	Sin Padaytha-6	Y2G-91062	2001
10.	Sin Padaytha-7	ICGV-93382	2001
11.	Sin Padaytha-8	ICGV-94310	2007
12.	Sin Padaytha-11	YZG-00019	2009
13.	Nyaung Oo-1	ICGS(E) (11) x Magway 15	2009
14.	Sin Padaytha-12	YZG-03008	2010

**Crop Name: Sesame**

Sr.No	Variety name	Line No./Original Name	Released year
1.	Sin Yadanar-1	Local	-
2.	Sin Yadanar-2	Local	-
3.	Magway-7/9	HC 7/9-3-3-3	-
4.	Magway-2/21	HB 2/21-1-1-4	-
5.	Hnan Ni-25/160	Hnan Ni-25/160	-
6.	Sin Yadanar-6	-	2003
7.	Sin Yadanar-12	-	2011

**Crop Name: Sunflower**

Sr.No	Variety name	Line No./Original Name	Released year
1.	Sin Shwe Kyar-1	Chernianka-66	-
2.	Sin Shwe Kyar-2	Chakinskyi-269	-
3.	Pale Nak	GOR-104	-
4.	Doe Khit	Peredovik	-
5.	Mahura	Smena	-
6.	Yezin Hybrid-1	A 8 x R 15	2002

**Crop Name: Long Staple Cotton**

Sr.No	Variety name	Line No./Original Name	Released year
1.	Yezin Chi Hmyin Shay-1	SRT-1	-
2.	Yezin Chi Hmyin Shay-2	H 229/78	-
3.	Yezin Chi Hmyin Shay-3	H 218/78	-
4.	Yezin Chi Hmyin Shay-4	H 228/78	-
5.	Stone Vile-213	STONEVILE-213	-
6.	Lun Kyaw-1	C-P-15/2	-
7.	Lun Kyaw-3	LRA-5166	-
8.	Htilar-1	CIM-70	-
9.	Htilar-3	ROIL-3	-
10.	LRA-5166	LRA-5166	2003
11.	MCU-9	MCU-9	2003
12.	SURABHI	SURABHI	2003
13.	MCU 5VT	MCU-5VT	2003
14.	Ngwe Chi-6	-	2006
15.	RAKA 666	-	2014

**Crop Name: Short Staple Cotton**

Sr.No	Variety name	Line No./Original Name	Released year
1.	Yezin Chi Hmyin Toe-1	AK-235	-
2.	Yezin Chi Hmyin Toe-2	Shyamal	-
3.	Yezin Chi Hmyin Toe-3	Lohit	-
4.	Mahlaing-8	M-62	-

**Crop Name: Jute**

Sr.No	Variety name	Line No./Original Name	Released year
1.	Yezin Thee Lone Pu-1	BC-48 (JRC-7447)	-
2.	Yezin Thee Lone Pu-2	BC-80 (JRC-212)	-
3.	Yezin Thee Lone Pu-3	BC-99(Jan-4)	-
4.	Yezin Thee Lone Pu-4	BC-32 (BG-1)	-
5.	Yezin Thee Lone Pu-5	BC-34 (March-2)	-
6.	Yezin Thee Taunt Shay-1	BO-23 (JRO-7835)	-
7.	Yezin Thee Taunt Shay-2	BO-17 (JRO-524)	-
8.	Yezin Thee Taunt Shay-3	BO-18 (JRO-878)	-
9.	Yezin Thee Lone Pu-7	BC-115 Salimose	2002

**Crop Name: Sugarcane**

Sr.No	Variety name	Line No./Original Name	Released year
1.	Yezin -1	Co-1148	-
2.	Yezin-2	Triton	-
3.	Yezin-3	Q-89	-
4.	Pyinmana-5	Phil-72/70	2003
5.	Pyinmana-6	Phil-74/64	2005
6.	Pyinmana 96-48	GPT-37xVMC-74/527	2005
7.	Pyinmana 96-56	NC <sub>0</sub> -310 x C <sub>0</sub> -578	2005
8.	Pyinmana 98/40	P M A – 98/40	2008
9.	Pyinmana 98/44	P M A – 98/44	2008
10.	Nawaday-2	K-88/92	2008
11.	Nawaday-4	K-95/84	2011

**Crop Name: Black gram**

Sr.No	Variety name	Line No./Original Name	Released year
1.	Yezin-1	VM-75-1/Pu-19 (India)	1975
2.	Yezin-2	VM-75-4/P-45-1 (India)	1975
3.	Yezin-5	P-69-354	2004
4.	Pale Htun	Yezin-3 Mutant Line	2006

**Crop Name: Green gram**

Sr.No	Variety name	Line No./Original Name	Released year
1.	Pedi Shwe Wah	VR 76-1 Bakti (Indonesia)	1976
2.	Yezin-2	VR 76-2/CES-14 (Philippine)	1976
3.	Mya Kyay Hmon-1	VR 75-7/ML-1 (India)	1975
4.	Mya Kyay Hmon-2	CES-87	1976
5.	Yezin-8	VR-2000-6 / VC-6366-7	2003
6.	Yezin-9	VR-2000-1 / VC-1973-A	2003
7.	Sike Pyoe Yay-1	VC-6469-12-3-4-A	2009
8.	Yezin-11	VR-2003-5	2007
9.	Yezin-14	YM 03-2-2	2011

**Crop Name: Pigeon pea**

Sr.No	Variety name	Line No./Original Name	Released year
1.	Yezin-1	CC-76-30/HPA-1 (India)	1976
2.	Yezin-2	CC-76-4/Yezin (India)	-
3.	Kywe Chan Shwe Dinga	Local	1976
4.	Nga San Pe	CC 76-51	1976
5.	Yezin-6	CC 04-8 (ICPL-96061)	2009

**Crop Name: Butter bean**

Sr.No	Variety name	Line No./Original Name	Released year
1.	Mahlaing Asay Pyar	PL 76-22	1975
2.	Mahlaing 27/30	-	1975

**Crop Name: Chick pea**

Sr.No	Variety name	Line No./Original Name	Released year
1.	Karachi	CA 25-23/Karachi (India)	1975
2.	Shwe Kyay Hmone	CA 75-18/8503/27 S (India)	1975
3.	Yezin-1	CA 75-9P 436 (India)	1975
4.	Sin Kalarpe-1	ICCV 2	2001
5.	Sin Kalarpe-2	ICCV 88202	2001
6.	Yezin-5	CA-85-125 ICCV-3	2000
7.	Yezin-6	CA-94-10 ICCV-92944	2000
8.	Yezin-8	(ICCL-81001 x ICCV-32) x (ICCV-49 x Flip-82-IC) x ICCV-3 (or) CA-03-35 Yezin-8	2009
9.	Shwe Ni Lone Gyi	ZCHL-2014 Shwe Ni Lone Gyi	2009
10.	Yezin-11	CA-02-25 ICCV 01309	2010

**Crop Name: Cow pea**

Sr.No	Variety name	Line No./Original Name	Released year
1.	Yezin-1	Vu-75-3 (American)	1975
2.	Yezin-2	Vu-75-4 (American)	1975
3.	Sin Pelwan Phyu-2	VU-02-6	2006

**Crop Name: Soybean**

Sr.No	Variety name	Line No./Original Name	Released year
1.	Yezin-5	GM-95-8 Samsoy-1	2003
2.	Sin Pepoke-6	GM-95-9	2008
3.	Sin Pepoke-11	GM-05-25	2008

**Crop Name: Tomato**

Sr.No	Variety name	Line No./Original Name	Released year
1.	Sin Khayan Chin-1	CLN-5919-93-D-4-1-0-3/BL-10	2003
2.	Sin Khayan Chin-2	CLN 2123 A	2008
3.	Sin Khayan Chin-3	CIN 2026D	2010
4.	Lora 909	Bwt5	2013

**Crop Name: Muskmelon**

Sr.No	Variety name	Line No./Original Name	Released year
1.	Kyauk Sein	-	2012
2.	Pale	-	2012

3.	Shwe	-	2012
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#### Crop Name: Cauliflower

Sr.No	Variety name	Line No./Original Name	Released year
1.	Poornima-008	Poornima-008	2013
2.	Artria-153	Artria-153	2013
3.	Penta 55	ST 1353	2013
4.	Snow Cloud	NS 555	2013

#### Crop Name: Cabbage

Sr.No	Variety name	Line No./Original Name	Released year
1.	Green Eden 123	Green Eden	2013

#### Crop Name: Hot pepper

Sr.No	Variety name	Line No./Original Name	Released year
1.	Azuma	Azuma	2013
2.	Tongla-692	Tongla-692	2013
3.	Fighter	Fighter	2013
4.	Demon	Demon	2013

#### Crop Name: Cucumber

Sr.No	Variety name	Line No./Original Name	Released year
1.	Hyper C	Hyper C	2003
2.	Nandini	Nandini	2003
3.	Saira	Saira	2003

#### Crop Name: Bitter gourd

Sr.No	Variety name	Line No./Original Name	Released year
1.	Best-165	Best-165	2013
2.	Palee	Palee	2013
3.	Maya	Maya	2013

#### Crop Name: Luffa

Sr.No	Variety name	Line No./Original Name	Released year
1.	Naga	Naga	2013

#### Crop Name: Radish

Sr.No	Variety name	Line No./Original Name	Released year
1.	Pan Queen	CRN.02	2013



## Appendix 3 National Seed Committee and Technical Seed Committee members

### National Seed Committee

(1)	Deputy Minister Ministry of Agriculture and Irrigation	Chairman
(2)	Managing Director ( <i>now Director General</i> ) Myanmar Agriculture Service ( <i>now Department of Agriculture</i> ) Ministry of Agriculture and Irrigation	Vice-chairman
(3)	Director General Department of Agricultural Planning Ministry of Agriculture and Irrigation	Member
(4)	Director General Foreign Economic Relations Department Ministry of National Planning and Economic Development	Member
(5)	Director General Department of Atomic Energy Ministry of Science and Technology	Member
(6)	Director General Department of Technology Promotion and Coordination Ministry of Science and Technology	Member
(7)	Deputy Chief of Police (or ) Representative Myanmar Police Force Ministry of Home Affairs	Member
(8)	Director General Directorate of Trade Ministry of Commerce	Member
(9)	Director General Customs Department Ministry of Finance	Member
(10)	Managing Director ( <i>now Director General</i> ) Myanmar Industrial Crops Development Enterprise ( <i>now Department of Industrial Crops Development</i> ) Ministry of Agriculture and Irrigation	Member
(11)	Rector Yezin Agricultural University Ministry of Agriculture and Irrigation	Member
(12)	Director General Settlement and Land Records Department Ministry of Agriculture and Irrigation	Member
(13)	Deputy Managing Director Cotton and Sericulture Division Myanmar Industrial Crops Development Enterprise Ministry of Agriculture and Irrigation	Member
(14)	Deputy Managing Director Perennial crops and Farms Division Myanmar Industrial Crops Development Enterprise Ministry of Agriculture and Irrigation	Member

(15)	Deputy Managing Director Jute and Fibres Division Myanmar Industrial Crops Development Enterprise Ministry of Agriculture and Irrigation	Member
(16)	Deputy Managing Director Sugarcane Division Myanmar Industrial Crops Development Enterprise Ministry of Agriculture and Irrigation	Member
(17)	Director General Department of Agricultural Research Ministry of Agriculture and Irrigation	Secretary
(18)	Deputy Director General Department of Agricultural Research Ministry of Agriculture and Irrigation	Joint Secretary -1
(19)	General Manager ( <i>now Director</i> ) Seed Division Myanma Agriculture Service ( <i>now Department of Agriculture</i> ) Ministry of Agriculture and Irrigation	Joint Secretary -2

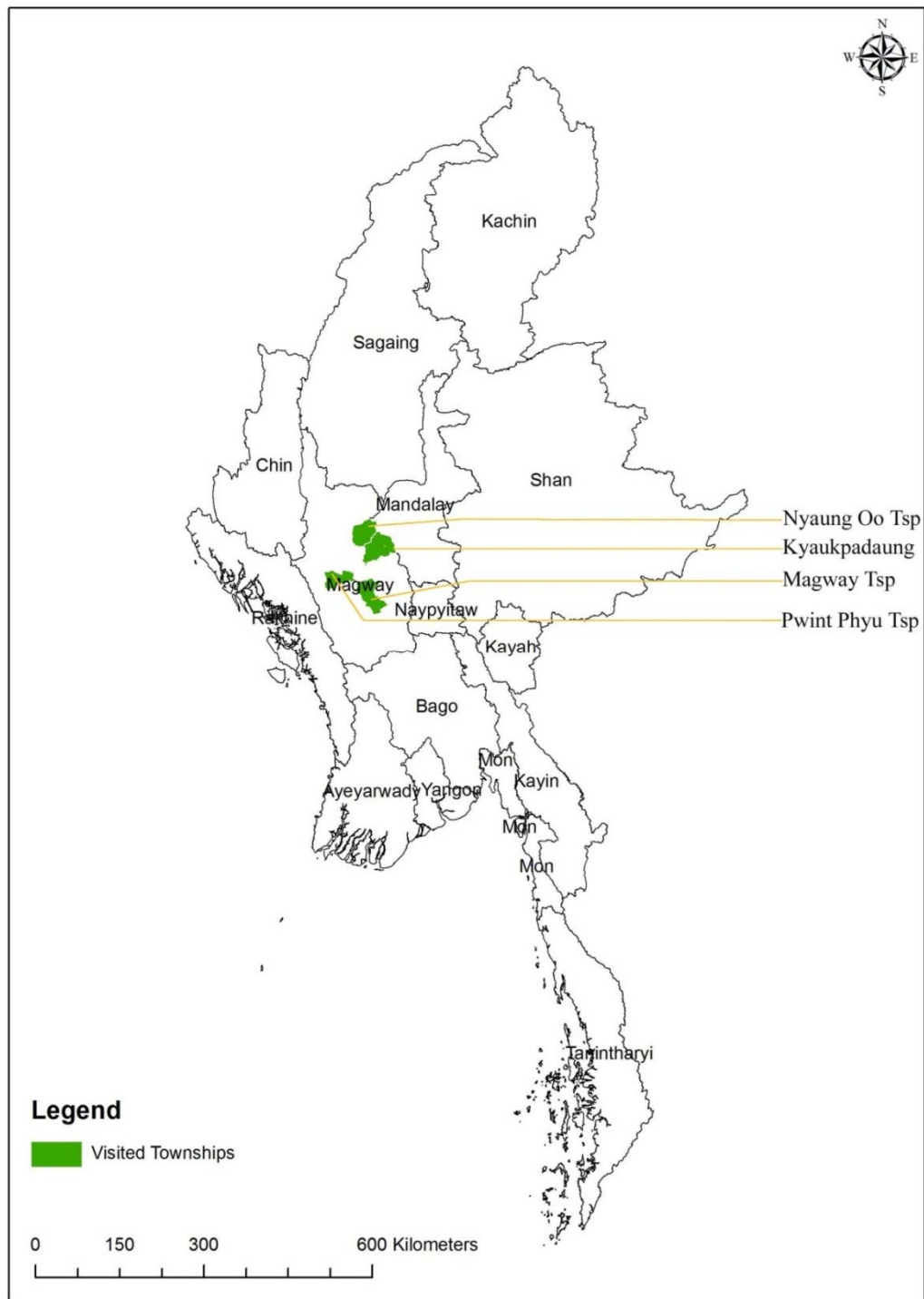
### Technical Seed Committee

(1)	Managing Director ( <i>now Director General</i> ) Myanma Agriculture Service ( <i>now Department of Agriculture</i> ) Ministry of Agriculture and Irrigation	Chairman	
(2)	Director General Department of Agricultural Research Ministry of Agriculture and Irrigation	Vice-chairman	
(3)	General Manager ( <i>now Director</i> ) Agricultural Extension Division Myanma Agriculture Service ( <i>now Department of Agriculture</i> ) Ministry of Agriculture and Irrigation	Member	
(4)	Director Rice Division Department of Agricultural Research Ministry of Agriculture and Irrigation	Member	
(5)	Professor Botany Department Yangon University	Member	
(6)	General Manager Cotton and Sericulture Division Myanmar Industrial Crops Development Enterprise Ministry of Agriculture and Irrigation	Member	<i>Now these divisions have been transformed as Cotton &amp; Sericulture Education &amp; Technology Development Division, Perennial Crops Education &amp; Technology Development Division, Jute &amp; Allied Fiber Education &amp; Technology Development Division, Sugarcane Education &amp; Technology Development Division under Department of Industrial Crops Development (previously Myanmar Industrial Crops Development Enterprise) and each division is headed by a Director.</i>
(7)	General Manager Perennial Crops and Farms Division Myanmar Industrial Crops Development Enterprise Ministry of Agriculture and Irrigation	Member	
(8)	General Manager Jute and Fibres Division Myanmar Industrial Crops Development Enterprise Ministry of Agriculture and Irrigation	Member	
(9)	General Manager Sugarcane Division Myanmar Industrial Crops Development Enterprise Ministry of Agriculture and Irrigation	Member	

(10)	General Manager Myanmar Industrial Crops Development Enterprise ( <i>now Department of Industrial Crops Development</i> ) Ministry of Agriculture and Irrigation	Member
(11)	Representative Yezin Agricultural University Ministry of Agriculture and Irrigation	Member
(12)	General Manager ( <i>now Director</i> ) Land Use Department Myanma Agriculture Service ( <i>now Department of Agriculture</i> ) Ministry of Agriculture and Irrigation	Member
(13)	Deputy General Manager ( <i>now Director</i> ) Plant Protection Department Myanma Agriculture Service ( <i>now Department of Agriculture</i> ) Ministry of Agriculture and Irrigation	Member
(14)	Deputy General Manager ( <i>now Director</i> ) Horticultural Unit ( <i>now Horticulture and Biotechnology Division</i> ) Myanma Agriculture Service ( <i>now Department of Agriculture</i> ) Ministry of Agriculture and Irrigation	Member
(15)	Deputy Director General Department of Agricultural Research Ministry of Agriculture and Irrigation	Secretary
(16)	General Manager ( <i>now Director</i> ) Seed Division Myanma Agriculture Service ( <i>now Department of Agriculture</i> ) Ministry of Agriculture and Irrigation	Joint- Secretary



## Appendix 4 Townships visited in the Dry Zone



To explore  
the potential  
of nature to  
improve the  
quality of life



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The Centre for Development Innovation works on processes of innovation and change in the areas of food and nutrition security, adaptive agriculture, sustainable markets, ecosystem governance, and conflict, disaster and reconstruction. It is an interdisciplinary and internationally focused unit of Wageningen UR within the Social Sciences Group. Our work fosters collaboration between citizens, governments, businesses, NGOs, and the scientific community. Our worldwide network of partners and clients links with us to help facilitate innovation, create capacities for change and broker knowledge.

The mission of Wageningen UR (University & Research centre) is 'To explore the potential of nature to improve the quality of life'. Within Wageningen UR, nine specialised research institutes of the DLO Foundation have joined forces with Wageningen University to help answer the most important questions in the domain of healthy food and living environment. With approximately 30 locations, 6,000 members of staff and 9,000 students, Wageningen UR is one of the leading organisations in its domain worldwide. The integral approach to problems and the cooperation between the various disciplines are at the heart of the unique Wageningen Approach.

