ASSESSING FARMERS' WILLINGNESS TO PAY FOR QUALITY SEEDS USING BIDDING EXPERIMENT MECHANISM: EVIDENCE FROM MYANMAR

By

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ABSTRACT

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In most developing countries the use of quality seeds of self-pollinated crops like pulses is low because of economic and biological factors. The purpose of this study was to better understand the market potential for private sector-led seed system for two important pulse crops—chick pea and green gram in the Central Dry Zone region of Myanmar. I used the Becker-DeGroot-Marschak bidding experiment mechanism to estimate farmers' willingness to pay (WTP) for seeds with different quality attributes and to assess the impact of seed packaging, branding, traceability, and labeling on farmers' WTP a premium for these quality-signaling attributes. For green gram, I also collected detailed cost data for producing seed and grain. Results indicate that providing information on the identity of the seed source, packaging, branding, traceability, and labeling had no statistically significant effect on farmers' WTP a premium for these attributes. I also found that visual inspection of seeds' physical attributes was an important determinant of farmers' WTP. Comparing the results with the cost analysis suggests that about 40% of the farmers' WTP for certified seed produced by the local seed producers and 65% of farmers' WTP for the company seed, which was perceived to be of highest quality was above the cost of seed production, which did not include storage, transport, and marketing costs. Results of this study suggest potential market demand exists for quality seed but more research is needed to better understand the cost structure and bring the total cost of producing and marketing seed below the WTP price for a large number of farmers.

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KEY TO ABBREVIATIONS

AMD	Agricultural Mechanization Department
BDM	Becker-Degroot-Marschak
CBSP	Community-based seed production
CS	Certified Seed
DAR	Department of Research
DOA	Department of Agriculture
EA	Enumeration Area
GDP	Gross Domestic Product
HA	Hectare
ISSD	Integrated Seed Sector Development
KG	Kilogram
MADB	Myanmar Agricultural Development Bank
MMK	Myanmar Kyats
MKT	Market
MoALI	Ministry of Agriculture, Livestock, and Irrigation
NGO	Non-profit Organization
OLS	Ordinary Least Squares
WTP	Willingness to Pay

Chapter 1: Introduction

Farmers' use of quality seed could help transform agriculture, together with better farm management, and public investment in research, irrigation, and other public goods. Agricultural transformation during the Asian Green Revolution in the 1960s through 1980s is one of the most prominent examples of such transformation led by seed-based research and development. The use of improved rice and wheat varieties, combined with better farm management, use of other inputs, and appropriate policies led agricultural yields and output to more than double within the span of 25 years from 1965 to 1990 in Asia (Hazell, 2009). A lesson learnt from this Asian Green Revolution experience is that the adoption of good quality seeds is essential for developing countries to experience agricultural transformation.

However, use of quality seeds of self-pollinating crops like green gram and chickpea is low in developing countries. This is a result of both supply and demand side constraints. Self-pollination produces progenies that are more uniform than those resulting from outcrossing. It is thus easier for farmers to retain seeds from harvest and reuse for a few generations without losing genetic quality. Thus, demand for seeds of self-pollinating crops is uncertain and fluctuating because of the competition from farm-saved seeds (David, 2004).

On supply side, quality seeds availability of these crops is more limited due to little interest by the private sector in producing them. These crops provide small profits to seed companies because of the lack of effective demand, low multiplication rates, and strong regionally specific preferences (David, 2004). At the same time, public institutions also do not have enough capacity to produce sufficient quantities (Katungi et al., 2011).

Increase in the adoption of quality seeds for self-pollinating crops using a market-based approach will require satisfying the following demand side and supply side conditions. On the one

hand, it requires effective demand, which comes from farmers' ability to perceive quality differences between quality seed categories and farm-saved seeds (i.e., legume grains) as well as affordability, accessibility, and farmers' willingness to pay (WTP) premium for the additional quality (Maredia et al., 2019). On the other hand, farmers' WTP premium needs to be sufficiently high to cover the cost differential in producing seed vs. grain, inclusive of profit margins needed to keep the private sector in the seed business.

Many studies have attempted to understand farmers' demand for improved varieties and their preferences for different seed attributes using elicitation methods, i.e., contingent and conjoint analysis as well as experimental mechanisms (for example, De Groote et al., 2011; Stevens and Winter-Nelson, 2008; Waldman et al., 2014; Horna et al., 2007). However, except for the recent study by Maredia et al. (2019), Posey (2018), and Bartle (2019), they have focused on testing consumers' preferences, demand, and WTP for varieties of different genetic attributes (i.e., varietal attributes). This study tries to fill the gap in the literature by examining farmers' demand for seeds of different quality, holding the genetic traits constant.

The objectives of this study are to study the seed demand of different quality products, to analyze the potential role of the local seed producers in the provision of quality seeds, and to understand farmers' behaviors towards different quality signaling mechanisms, i.e., branding, packaging, traceability information, and a label containing lab test results. Using both supply and demand side evidences, it intends to examine the supply side and demand side issues facing many self-pollinated, staple crops, using chickpea and green gram as case examples.

The overall research question of this study is similar in spirit to the recent studies by Maredia et al. (2019) and Bartle (2019). For example, Maredia et al. (2019) used the double blind experiments and experimental auctions to test farmers' willingness to pay for three bean and

cowpeas seed products of different quality and cost: certified, quality declared, and recycled. Its main focus was to evaluate farmers' willingness to pay price premiums for different seed quality as reflected in their perceived agronomic performance.

Bartle (2019), on the other hand, used only auction experiments to evaluate farmers' willingness to pay for three different seed quality products of potato seed from the formal (certified seed), informal (recycled seed), and semi-formal (clean seed) system. In addition, his study also focuses on whether the role of information such as communicating information about the quality assurance (QA) process and the effect of trust such as revealing the brand name and identity of seed producers have any effect on farmers' WTPs for these quality attributes.

Like Maredia et al. (2019) and Bartle (2019) this study evaluates the willingness to pay for seeds of different qualities from three different seed systems—formal, semi-formal, and informal. How farmers form an opinion about seed quality before expressing their WTP is what distinguishes this study from Maredia et al. (2019). In the study by Maredia et al. (2019), farmers' perception of quality was based on the agronomic performance of plants in fields planted with different seed types. In this study we use an approach similar to Bartle (2019) where farmers' perception of seed quality is based on visual characteristics of seeds presented to them.

As with many products, it is possible that for seeds also, the identity of source could signal the quality of products. Thus, similar to the study by Bartle (2019), this study compares the effects of quality signaling information embedded in seed source—such as formal (seed company and government), informal (market and farmer saved grains), and semi-formal systems (local seed farmers)—on farmers' willingness to pay. But unlike Bartle's (2019) study, this study also evaluates the effect of other quality signaling attributes such as packaging, branding, traceability, and labeling the package with information on lab test results on farmers' WTP. Most of the seeds

in the market including the government supplied certified seeds are currently sold in bulk without any package, brand name, supplier contact information, and quality lab test. In a well-developed market system, this marketing information could signal quality, and therefore, influence farmers' WTP.

In Myanmar like other developing countries, most pulse producing farmers rely on recycled seeds from the market or saved seeds from other farmers as planting material (Broek et al., 2015). Since the private sector has limited interest in producing seeds of these crops, many farmers purchase quality seeds (i.e., certified seeds) from the government, and have little exposure to the private seed suppliers. Given this little exposure to private seed suppliers and weak quality assurance mechanisms in Myanmar, many farmers are likely to trust the certified seeds provided by the government more. However, there is growing interest from the government to encourage more private sector engagement in the seed sector for major crops, including pulses. Thus, in this study, we investigate if farmers value seeds from other sources such as seed company and local seed producing farmers, differently from the government.

To my knowledge, research studies on the effects of this various types of quality signaling information are rare. One exception is the study conducted in India by Banerji et al. (2016) who studied farmers' willingness to pay for high iron pearl millet and the effects of branding/labeling and certification on farmers' WTP. Therefore, this study also contributes to the nascent literature by testing the effects of quality signaling information on WTP.

I used the evidence from bidding experiment mechanism with about 500 farmers in the Central Dry Zone of Myanmar. By displaying recycled seeds (grains) from two different sources—from farmers and the market, and certified seeds from three different sources—from the government, seed company, and local seed producing farmers, I tested whether farmers are willing

to pay for perceived quality differences signaled by the information on seed sources. Two rounds of experimental mechanisms were designed to additionally measure the effects of packaging, traceability information (i.e., providing the supplier contact information), and the value of including information on seed quality test results such as the level of purity (i.e., seed free from foreign substances), moisture level, and germination rate on WTP.

Recently, development of the semi-formal system of seed production at the local level, i.e., farmers producing certified or quality declared seeds for sale in the community, has been promoted as an alternative means to increase the availability of quality seeds. This local (or community based) seed system has certain advantages over the formal seed system as it could produce quality seeds cheaper and can meet the needs and preferences of local farmers better (Rubyogo et al., 2007). Seeds from local farmers are also more readily accessible and have more accountability since producers are located locally.

Despite the local seed system's advantages and potential role in producing quality seeds on a commercial basis, there is almost no empirical study that has systematically documented the role of a community-based local seed system from both demand and supply-side perspectives. To fill this gap, the study also tests the viability of the local seed system using evidence from experimental mechanisms as well as conducting the cost of production survey of 12 green gram seed producing farmers in the study area. We used the cost of production survey to calculate the cost of producing green gram seeds and then compare the cost with farmers' WTP using evidence from experimental mechanisms. As the local seed production system is not yet prevalent in Myanmar, this sample of 12 seed producers represents all the farmers producing green gram certified seeds in the Central Dry Zone of Myanmar.

This study contributes to the burgeoning literature by generating an understanding of farmers' demand for quality seed and helps guide policy decisions related to the development of an effective and efficient seed sector in Myanmar as well as in other developing countries. This study also serves as one of the first one to quantitatively document the demand for seed of two important crops, chickpea and green gram, in Myanmar using an experimental mechanisms approach.[1]

As a preview of the results of this research, I would like to highlight three major findings. First, this study finds that farmers are willing to pay a premium for the perceived quality differences between certified seeds and farm saved seeds. Farmers are willing to pay the highest premium for the company seed, followed by the seed produced by the local farmers, and the government. Not surprisingly, farmers valued recycled seeds from the market the least.

Second, in the absence of a functioning quality assurance system and information asymmetry, farmers rely on assessing the quality of seed through observable characteristics and visual inspection rather than packaging, branding, and traceability information. Also, the study did not find an incremental value of including information on the government's lab test labels, which suggests the ineffectiveness of government's current certification and quality assurance system, and consequently lack of trust in government certification.

Third, this research supports the viability and the potential role farmer seed producers can play in the provision of quality seeds. The average cost of producing green gram seed from planting to harvesting was estimated to be Kyat 2,400/kg. About 65% and 40% of farmers' WTP for seed

[1] Green gram and chickpea play a significant role in agricultural growth in terms of higher farm profitability and generating export revenue since Myanmar is the second largest exporter of pulses after Canada (Raitzer et al., 2015).

was equal to or above this break-even point for seeds that were labeled as sourced from a seed company and a local seed producer, respectively. Because this breakeven cost does not include post-harvest costs such as storage, transport, and marketing, and producers' expected profit margins, the estimated potential demand of 40% to 65% of farmers is an upper bound estimate. Actual effective demand would be lower than these percentages when the post-harvest costs and profit margins are included, which would increase the seed market price. Nonetheless, this study suggests that seeds by local seed producers have market potential if they can produce seeds similar to the perceived quality of company seeds. This study also suggests the important role the government can play in providing finance and training to local seed producers, and extension services to farmers to sensitize them on the importance of quality seeds to increase the demand for quality seeds.

The rest of this thesis is organized as follows. In chapter 2, I present literature review, in chapter 3 I discuss the research methods and empirical strategy, followed by the descriptive analysis in chapter 4. In chapter 5, I present results, and in chapter 6, I conclude with discussions and implications.

Chapter 2: Literature Review

2.1: Myanmar's Agriculture

Since the end of the military dictatorship in 2011, Myanmar has undergone many economic and social reforms. Myanmar has experienced rapid economic growth. The real GDP growth in 2019 was 6.4%. Together with its rapid economic growth, the country has experienced rapid economic structural change, whereby, the contribution of the agriculture sector to country's GDP has dropped while the share of other sectors has increased (See Table 2.1). However, agricultural development is still vital to the economy, as about 50% of the total labor force is employed in the agriculture sector (See Table 2.1).

The large share of the total labor force relative to the small share in total GDP contribution by the agriculture sector indicates low level of agricultural productivity in Myanmar. Even during the period of economic liberalization and reforms starting in 2011, Myanmar's agriculture did not experience much improvement due to the lack of development in productivity, high volatility in output prices and yields, and the inability to eliminate existing policy distortions. Compared to the other sectors, the growth rate of the agricultural sector has been the lowest since 2011 (See Table 2.2).

However, Myanmar's agriculture has enormous advantages in terms of land and water endowment as well as diverse agro-ecological zones and market access. Myanmar has exclusive access to four main rivers, which supply more than 19, 000 cubic meters per capital of fresh water every year (ADB, 2012). The availability of fresh water is a more abundant in Myanmar compared to the neighboring countries. It has nine times and 16 times more fresh water than that of the People's Republic of China (PRC) and that of India, respectively (Raitzer et al., 2015). Currently, less than 10% of the available supply is utilized. When water access becomes the major constraint

globally, the abundance of water supply could be beneficial to the sector's growth if proper policies are in place.

Myanmar is also abundant in arable land and diverse in agro-ecological zones. Currently, there are 12.8 million hectares of cultivated land, and this could be additionally expanded by about 50% into fallow areas (Raitzer et al., 2015). Myanmar is also diverse in topography and ecosystem so that it can produce various crops such as cereals, pulses, horticultural products, fruits as well as livestock and fishery products.

Myanmar is also well-positioned in terms of market access. It is located in Southeast Asia, neighboring India and Bangladesh to the west, Thailand and Laos to the east, the People's Republic of China to the north and northeast. Proximity to the two largest food markets, India and China, gives Myanmar's agricultural products competitive advantages in terms of lower transportation and cheaper transaction costs (Raitzer et al., 2015).

Despite those advantages, the agriculture sector is yet to reach its potential. One of the major crops, paddy, for instance, has the second lowest yield in Asia after Cambodia in 2013/2014 (World Bank, 2017). Among other things, the slow growth of agriculture stems from three main constraints—low productivity, high volatility, and policy distortions.

Table 2-1: Agriculture's Share in GDP, Share in Labor Force, and Share in Total Merchandise Exports (%)

	2005/06	2010/11	2015/16
Agricultural in % of GDP	47	37	29
Agricultural labor force in % of total	65	52	50
Agri-food exports in % of total merchandise exports	9	25	30

Source: World Bank, 2017

Table 2-2: Percentage of Sectoral Growth

	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Agriculture	-0.7	1.7	3.6	2.8	3.4	4.3
Industry	10.2	8	11.4	12.1	8.7	4.5
Services	8.5	12	10.3	9.1	9.1	9.5
Total	5.6	7.3	8.4	8	7.3	6.5

Source: World Bank, 2017

One of the reasons for low agricultural productivity in Myanmar is the result of low and inappropriate level of inputs use. In 2013/2014, the supply of quality seeds could meet only 0.35% of paddy seed demand, and seed supply for other crops is expected to be even lower (World Bank, 2017). The government's inability to provide breeder and foundation seeds as well as the limited participation by the private sector are additional factors that lead to the limited seed availability as well as the low level of quality seed adoption (World Bank, 2017).

The use of other inputs such as fertilizers, pesticides, and agro-chemical products is also not optimal in Myanmar. The poor quality of fertilizers, and other inappropriate pesticides and agro-chemical related products imported from China are very common in Myanmar (Raitzer et al., 2015). The World Bank and LIFT study in 2016 also found that there was not much profit difference between farmers who used low amounts of fertilizers at 30 kg/ha and farmers who used high amounts of fertilizer at 392 kg/ha (See Table 2.3) (World Bank, 2016). Due to the lack of extension support and farm education, Myanmar's farmers have poor knowledge of fertilizer application and fertilizer use.

Table 2-3: Fertilizer Use and Productivity in Myanmar

	Low Use	Medium Use	High Use
Application of fertilizers, kg/ha	30	137	392
Cost of fertilizers, $/ha	23	74	178
Yield, wet paddy, tons/ha	2.74	3.13	3.28
Total costs, $/ha	330	426	617
Gross profit, $/ha	233	221	204
Net profit, $/ha	168	136	109
Labor productivity, $/day	4.52	3.95	4.24

Source: LIFT and World Bank, 2016

The global experience shows that long-term agricultural growth and productivity gains come from investments in agricultural research. Together with extension, education, and infrastructure, agricultural research brings innovative ideas and knowledge of better use of inputs and farm practices. Agricultural research also increases total factor productivity, meaning gains in agricultural productivity without having to increase farm intensification. Agricultural research is, therefore, important for long-term growth in Myanmar. However, investment in agricultural research was only 0.04% of agricultural GDP in 2016/2017 compared to 0.32% in Thailand and 0.62% in China during 2000 and 2011 (World Bank, 2017).

Another problem contributing to slow agricultural growth is high volatility in terms of yield and output market. Out of 187 countries, Myanmar ranks 3rd most affected by extreme weather events between 1998 and 2017 in the global climate risk index (Eckstein et al., 2019). The erratic rainfall and poor water control have increased the volatility of crop yields in Myanmar (Haggblade et al., 2013).

The lack of diversification in the output market is also one of the major constraints in Myanmar's agriculture. In terms of the output market, Myanmar is largely dependent on China, India, and a few other countries. Myanmar exports 70% of its pulses to India, 90% of watermelon to China, and 75% of onions to Thailand (Haggblade et al., 2013). The dependence on a few markets creates fluctuations in the output prices greatly, especially when the demand for the crop in importing countries swings. The improvement in crop quality and stability in quantity is one of the critical factors for Myanmar to diversify and seek potential export markets. This could only achieve with higher investment in research that could bring innovative technology, i.e., the improved varieties, investment in extension, which could improve the optimal use of inputs and farm management, and investment in infrastructure, which could lower the transaction costs.

The underperformance of the agricultural growth in Myanmar is also a result of several policy distortions. The misallocation of agricultural spending is one of the examples. The World Bank study (2017) on agricultural public spending finds the misallocation of resources in the sector. More than half of the current agricultural spending goes to irrigation, followed by agricultural mechanization, while resources allocated to other important areas like agricultural research remains very low (See Table 2.4). For instance, only 1.6% of the total agricultural spending goes to the Department of Agricultural Research, which is one of the main departments responsible for conducting agricultural related research in Myanmar.

Despite high budget allocation going to irrigation, the irrigation system is largely inefficient. Between 2011 and 2015, the irrigation spending doubled; however, the irrigation coverage only increased by 3 percent (World Bank, 2017). Besides, the agricultural productivity in the locations with public irrigation is not different from those under the rain-fed system. This is mainly because most of the dams were constructed to provide irrigation for water-intensive paddy farming, which is not readily convertible to productivity growth for other crops.

Moreover, a large amount of public spending on agricultural mechanization could also be reduced and reallocated to other vital areas. Agricultural mechanization department (AMD) is responsible for purchasing tractors and combine harvesters and providing rental services to farmers. However, the study by Win et al., (2017) on mechanization in the Delta region found that the widespread mechanization is due to the rise of private machinery dealers and private rental services. The study found no household in the survey area receiving machinery rental service provided by AMD in Ayeyarwady Delta. This is because the public system does not have enough capacity to deliver services to many locations. Besides, it could also not meet the preferences of the local demand, i.e., inability to rent or sell the brand of the machines that farmers prefer as well

as the inability to provide servicing such as the sale of accessories and repair services to the customers. This suggests that the current private sector-led mechanization is highly efficient, and the public spending in this area could be reallocated to other departments.

Table 2-4: MoALI Budget Spending across Departments in 2017/18

	2016/17	2017/18
Minister's Office	0.4%	0.3%
Department of Agricultural Mechanization	18.4%	25.6%
Department of Agricultural Planning	0.1%	0.1%
Department of Agricultural Research	1.6%	1.4%
Department of Agriculture	13.6%	8.8%
Irrigation and Water Utilization Department	54.4%	49.8%
Agricultural Land Management and Statistics	5.2%	5.4%
Yezin Agricultural University	0.9%	1.5%
Department of Fisheries	0.9%	2.1%
Livestock Breeding and Veterinary Department	3.0%	3.6%
University of Veterinary Science	0.3%	0.2%
Cooperative Department	0.6%	0.8%
Small Scale Industries Department	0.2%	0.2%
Total budget, million Kyats	613,682	596,354

Source: World Bank, 2017

Another significant policy distortion is the rice-centric policy. Rice is the major crop cultivated in Myanmar. It contributes 43% of the total production value in 2012 (Raitzer et al., 2015). Rice is also the main staple food in Myanmar. For political and food security reasons, the government has prioritized paddy farming in terms of irrigation access, credit and seed provisions, and provisions of other public services. For instance, the credit received by non-paddy farmers from Myanmar Agricultural Development Bank (MADB) is three times less than that of paddy farmers. It provides 150,000 kyats (approximately $100) per acre for up to 10 acres to rice farmers whereas other non-paddy farmers receive only 50,000 kyats (roughly $33) per acre for up to 10 acres.

However, crop diversification and policy orientation towards other crops which have a better comparative advantage is essential for the growth of the agriculture sector. Pulses, for

instance, have lower production costs and higher returns. Green gram is five times more profitable than monsoon paddy rice (See Table 2.5). Myanmar is the second largest exporter of beans and pulses after Canada (Raitzer et al., 2015). Beans and pulses contribute to the largest share in agricultural export value. The exported value of bean and pulses was US$ 1,152 million, whereas rice, livestock, fishers, and other agricultural related products each generated 400-500 million in 2015/16 (World Bank, 2017).

Table 2-5: Net Profits and Labor Productivity by Crop

	Net Profit, $/ha	Labor productivity, $/day
Green Gram	581	15.92
Sunflower seeds	377	15.68
Groundnuts	324	8.32
Black gram	267	9.29
Dry season paddy	246	9.20
Sesame	202	8.54
Chickpeas	141	6.85
Monsoon paddy	114	4.75

Source: World Bank, 2017

2.2: Seed Sector in Myanmar

Many studies on Myanmar's agriculture highlight the development of the well-regulated input sector as one of the essential aspects of agricultural transformation (Haggblade et al., 2013; Raitzer et al., 2015; NESAC, 2016). As a study by ADB argues, "Low input, low productivity, low-quality output and low returns" caught Myanmar's agriculture in "low equilibrium trap" (Raitzer et al., 2015). While low productivity is one of the constraints of Myanmar's agriculture, the development in the input sector could be one of the crucial strategies to tackle it as well as low quality and diversification of output markets.

Seed is the most basic form of agricultural input, and the development of the seed sector, together with other appropriate policies, could help transform Myanmar's agriculture. Myanmar could learn from the experiences of neighboring countries like India. Along with better farm

management practices, irrigation, and public policies, the adoption of improved varieties during the Green Revolution led wheat and rice yield in India more than double in a span of 25 years from 1965 to 1990 (Hazell, 2009).

The increase in the adoption of improved varieties is also one of the critical factors that can help solve some challenges faced by Myanmar's agriculture. It can improve the quality of output products and at the same time, decrease the volatility of output yields. The increase in productivity and quality will help improve Myanmar's ability to diversify its market away from China and India to other high-value export markets.

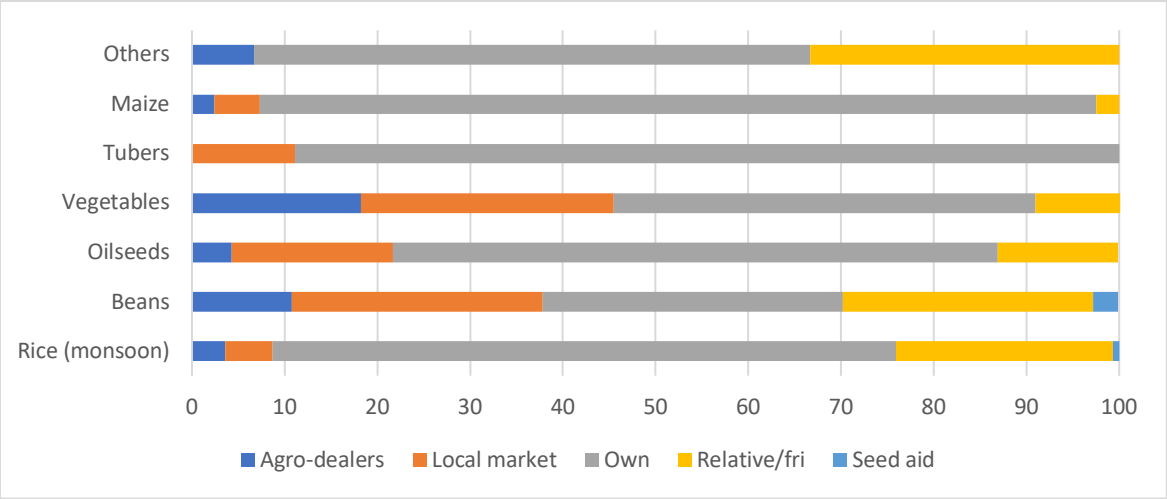
Despite its importance and implications for agricultural transformation, the level of quality seed adoption, as well as the availability, is currently low in Myanmar. More than 90% of cultivated seeds come from the informal sector (Broek et al., 2015). Majority of seeds are retained from farmers' own harvest or purchased from the market or received from friends or relatives (See Figure 2.1).

Quality seed supply is very limited in Myanmar, while the government mainly dominates the formal seed system. In 2013- 2014, the public seed sector provided less than 5% of the paddy seed requirement. The seed supply is expected to be even lower for non-paddy crops; for instance, less than 0.8% of the green gram seed requirement was fulfilled in 2013-2014.[2] This is mainly

[2] In 2013-2014, the government produced 82.63 tons of certified seed for green gram (MoALI, 2014). The total green gram sown area for that year was around 1.2 million hectares according to the Myanmar Central Statistical Organization 2016 data, so if we assume at the seed rate of 8 kg/hectare, only 0.8% of the green gram seed requirement were fulfilled for green gram.

because the government has historically prioritized rice in terms of seed supply, access to irrigation, and other public services for food security and political reasons.[3]

Figure 2-1: Seed Sources for Major Crops Produced in Myanmar



Source: FAO, 2016

Myanmar's current seed sector can be classified into three major systems ¬—the informal system, the intermediary system, and the formal seed system. These three systems are different in their target crops, the quality of seeds, variety, and distribution channels. The advantages and disadvantages of each system are also different. Their differences are summarized in Table 2.6.

The informal seed system includes farm-saved seeds, grains purchased as seeds at the local market, and grains purchased as seeds from other farmers. Most of the varieties in the informal seed system are local varieties (Broek et al., 2015). The advantages of the informal seed system are that varieties are well adapted to the local conditions; farmers are familiar with quality as they might be buying from the same farmers or same vendors, and seeds are affordable and easily

[3] Rice is a main staple food in Myanmar. An average Myanmar person eats 190 kilograms of rice per year. <https://www.horizonagribusiness.com.au/single-post/2017/08/05/Myanmar-consumes-190kg-of-rice-per-capita>

accessible. However, the disadvantages can be genetic mixtures and low seed quality as reflected in the seed health (i.e., presence of seed pests and diseases) and low vigor.

The semi-formal system such as the community-based seed production (CBSP) is not yet popular in Myanmar. The system has recently introduced by NGOs and other development organizations (Broek et al., 2015). Integrated Seed Sector Development (ISSD), for example, is one of the non-profit organizations (NGO) that worked with the local farmers to produce the certified seeds. The advantage of this system is that farmers are trained to produce quality seeds, so the seed quality is higher. The question for this type of system is the ability to produce seed on a commercial basis.

The formal seed system is mainly dominated by the government, while the private sector involvement is minimal. The formal sector meets only a small portion of the seed demand. It includes the government and the local seed companies. The government mostly focuses on rice, whereas private companies are primarily producing hybrid seeds of vegetables, fruits, maize, and rice (See Table 2.6). Out of 43 companies active in seed production in Myanmar, 39 are producing seeds of hybrid corn and vegetables (MoALI, 2016).

Almost no private players in the formal system produce the seeds for self-pollinating crops such as legume crops. The involvement of the private companies is also limited. The private companies are involved in the last stage of seed production, i.e., multiplication of certified seeds for field crops such as rice, wheat, maize, and millet.

Table 2-6: Summary of Different Seed Systems in Myanmar

	Informal	Semi-formal	Formal	
Parties Involved	Farmers, Local traders	NGOs, farmer organizations	Government	Private Companies
Targeted Crops	Any type	Rice, pulses, beans & oilseeds	Any type with rice focus	Vegetables, Hybrid rice, hybrid maize
Variety	Local	Improved and Local	Improved (OPV and Hybrid)	Improved (mostly Hybrid)
Advantages	-adaptable to local condition	-higher quality	-yield and quality	
	-farmers' familiarity with the variety		-Genetic Traits (such as weather resistance)	
	-cheap			
	-easy accessibility			
Disadvantage	-quality and yield	-Production Scale and commercialization	-expensive	
			-accessibility	
			-mainly hybrid and rice focus	
Distribution Channels	-farmers to farmers	-exchange	-Contact farmers and agro-dealer shops	
	-traders			
	-grain markets			
	-saved seed			
Type of Seed	Not Certified	Certified	Certified	

Source: (Broek et al., 2015 and MoALI, 2016) adapted by author

Public Seed System

There are two main departments responsible for the seed sector. Under the Ministry of Agriculture, Livestock, and Irrigation (MoALI), the Department of Agricultural Research (DAR) and the Department of Agriculture (DOA) are the two key players for the seed system. In terms of seed production, DAR is mainly responsible for developing new varieties and producing the breeder and foundation seeds. DAR has 24 research stations across different agro-ecological zones in the country. The research stations are in charge of testing new varieties for quality, local adaptability, and pest (Oo and Shwe 2014). Figure 2.2 summarizes the main responsibilities undertaken by DOA and DAR.

DAR and the seed division of DOA also have 43 seed farms, which produce the foundation and registered seeds (MoALI, 2016). These government seed farms then provide the foundation and registered seed to contact farmers, private seed companies, and NGOs, to multiply certified seeds (Broek et al., 2015).[4] Then, the seeds are distributed through township level extension agents under the DOA and agro-dealers. Figure 2.3 indicates the different seed class levels that each department is producing.

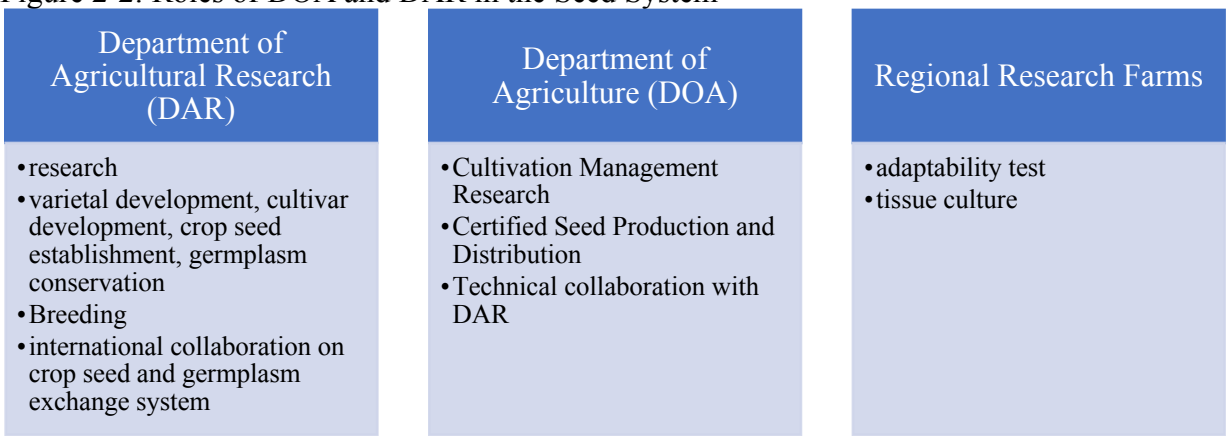
Myanmar's Seed System Reforms and Challenges

Together with other economic liberalization and social reforms after the end of the military regime, the seed sector has also undergone some reforms in recent years. The new seed law was enacted in 2011 (MoALI, 2016). The new plant variety protection law and seed policy were also approved

[4] Contact farmers work with the Department of Agriculture (DOA) under a contract arrangement to multiply certified seeds for the government. DOA provides technical support to contact farmers and oversee the quality control process. DOA then buys the certified seeds from them and stores seeds for distribution in next season (Oo and Shwe 2014). Contact farmers are sometimes working with NGOs to produce certified seeds for self-pollinating crops. Integrated Seed Sector Development (ISSD) is one of those organizations in Myanmar.

in 2016. In 2016, the government also developed and agreed on the road map for Myanmar's seed sector for the 2017-2020 period (World Bank, 2017).

Figure 2-2: Roles of DOA and DAR in the Seed System



Source: (MoALI, 2016) adapted by author

Figure 2-3: Different Seed Classes Produced in Myanmar and Responsible Parties

Source: (MoALI, 2016) adapted by author

The new seed law that was enacted in 2011 mainly includes rules and regulations related to the government, seed laboratories, and seed businesses (FSWG, 2015). The seed law covers four main issues: commercial seed business and licensing, laboratories for seed testing and regulation, production and importing of new varieties, and the role of the government in the seed sector. One of the most important liberalizations under the new seed law is the permission given

to the private seed companies to have their own seed testing facilities after they get the government registration certificate (Broek et al., 2015).

The national seed policy was also drafted in 2013, but the seed policy was not yet adopted by the Parliament (FSWG, 2013). The seed policy proposes to reduce the role of the government and expand the role of the private sectors in term of registered and certified seed production and internal quality assurance especially in hybrid rice and maize (Broek et al. 2015). The role of the government is to be gradually reduced from commercial operation to the provision of public services and facilitation (FSWG, 2015). The government will focus on providing public services such as research, production of foundation and breeder seeds, ensuring the overall seed quality assurance, and provisions of extension service to boost the demand of the quality seed (MoALI, 2016). Most importantly, the seed policy highlights the importance of the informal sector in seed provisions, i.e., encouraging the local seed producers to produce certified seeds on a commercial basis and gradually transforming the informal sector to formal seed production.

However, given the weak regulatory framework and limited institutional capacity, the biggest challenge to the reforms of the seed sector is the implementation issue. The problem is inherent in the limited availability of technical and human recourses. For instance, DOA's seed division is responsible for the inspection of seed production, but seed companies and seed villages where contact farmers are located rarely receive formal inspection (Broek et al. 2015). The seed division still does not have any systematic procedure in place and enough human capacity to conduct field inspection and do laboratory testing (Oo and Shwe 2014).

Seed farms and laboratories are limited in budget, equipment, and facilities (World Bank 2015b; Myanmar Agriculture Network 2016). The laboratories need to be modernized, and the majority of them can provide only basic testing (World Bank, 2017). The plant variety protection

law which guarantees the intellectual property/breeder rights is yet to be enacted. In its 2016 report, the World Bank ranked Myanmar 34th place out of 62 countries in terms of having an enabling environment for plant breeding, variety registration, and seed quality control (World Bank 2017a).

At the same time, it is crucial that the government needs to reduce red-tape and opaque rules further (i.e., cumbersome rules in business registration) to attract more private sector's participation. According to the World Bank's Ease of Doing Business Indicators in 2019, Myanmar ranked at 171th out of 190 countries. However, Myanmar's agriculture has many competitive advantages to experience the transformation. The increase in technology adoption, together with the elimination of policy distortions and investment in research, infrastructure, and extension will help Myanmar experience agricultural transformation.

2.3: Literature on Seed Adoption

The adoption of quality seeds is the most basic and essential form of technology adoption, which can lead to agricultural growth and transformation, if accompanied by appropriate policies and the use of other complementary inputs. In the past few decades, the development community has made a significant investment in developing improved varieties of self-pollinated crops, such as green gram, chickpea, pigeon pea, rice, and kidney beans (Eriksson et al., 2018; Walker and Alwang, 2015). Still, the adoption of improved varieties in developing countries is low, and the use of quality seeds (such as certified seeds) is even lower in places where quality seeds are available and could be profitable (Hoogendoorn et al., 2018).

There is vast amount of literature that investigates farmers' valuations and preferences related to seed adoption using different research tools. This includes surveys to understand farmers' characteristics and the level of seed varietal adoption as well as factors that influence such adoption decisions; willingness to pay studies using revealed or stated preferences methods,

i.e., contingent valuation and conjoint analysis; and experimental mechanisms with games or real money (Almekinders et al., 2019). Other methods such as the participatory breeding approach, rapid rural appraisals, and farmer panels are also widely used to study farmers' seed demand and preferences.

Using the observation data (household-level surveys) and empirical models (for example, Probit, Tobit, and Logit), many studies have examined the factors that determine or influence the adoption of seeds of improved varieties or other technologies in general. This literature reveals that socio-economic characteristics, demographic characteristics, and institutions (for example, extension, input supply market, etc.) are critical factors influencing adoption decisions (Negatu and Parikh, 1999).

For example, the study by Gerhart (1975) in Kenya showed the role of education in influencing the adoption of hybrid maize seeds. Ghimire et al. (2015) identified the impact of land size and the ownership of favorable land type (e.g., lowlands) on the probability of adopting new rice varieties in Central Nepal. The study by Ghimire et al. (2012) indicated how seed access influences the adoption of new wheat seed varieties in India. Similarly, Kaliba et al. (2000) demonstrated that the availability of extension services and on-farm field trials drove the adoption of improved maize seeds in Tanzania.

Even with the proliferation of research into the factors that drive farmers' seed adoption decisions, the adoption of improved varieties as well as quality seeds is still a mystery. Thus, literature highlights the need for a better understanding of farmers' demand for quality seeds (for example, De Roo and Gildemacher, 2016) as well as more effective seed dissemination approach (for instance, Atlin, 2017; Eriksson et al., 2018; Rajendran, Kimeye and McEwan, 2017) to

understand the quality seed adoption better and increase the use of quality seeds in developing countries.

Many studies have focused on studying demand for seeds of improved varieties with different genetic traits. Research has given its focus on eliciting farmers' preferences and demand so that the development of the improved varieties is in accordance with farmers' demand and farmers' needs which will help improve seed diffusion (Almekinders et al., 2019). For example, Horna et al. (2007) examined farmers' preferences for new rice varieties and their willingness to pay (WTP) for seed-related information in Nigeria and Benin using conjoint utility analysis and contingent methods. This study found that farmers' preference for a variety depends on the utility they receive from its attributes. The study also concluded that the attributes that farmers prefer vary across socio-economic characteristics.

Other seed demand studies that used conjoint analysis method include the studies by Kassie et al., (2017); Birol et al., (2012), and Birol et al., (2015). Kassie et al. (2017) estimated implicit prices that farmers are willing to pay for drought tolerance in maize compared to other preferred traits using a choice experiment framework in Zimbabwe. The study revealed that farmers are willing to pay a premium for drought tolerant seeds and identified that drought tolerance, grain yield, covered cob tip, cob size, and semi-flint texture are the most preferred traits. Birol et al. (2012) estimated farmers' willingness to pay for Bt seeds and other essential attributes in the Philippines and found differences in farmers' preferences and their willingness to pay across different agro-ecological zones for information and seed acquisition. Likewise, Birol et al. (2015) also investigated farmers' preferences and trade-offs among different production and consumption attributes of pearl millet varieties in India. The study found significant heterogeneity in farmer

preferences concerning production and consumption attributes between households which produce millet for household consumption and those that produce for market sales.

Many of the past seed demand studies also used experimental mechanisms to elicit farmers' preferences and demand for varieties. De Groote et al. (2010) used the Becker-DeGroot-Marschak (BDM) experimental mechanism approach to study farmers' willingness to pay for orange and biofortified maize seeds in Ghana. The study found that farmers' preferences for white and yellow maize varieties varied across regions, and dissemination of nutritional information through a proper channel such as radio could influence farmers' valuation of these varieties (De Groote et al., 2010).

Similarly, Groote et al. (2011) also tested consumer willingness to pay for yellow versus fortified maize meal in Kenya using both the BDM approach and Vickrey or second-price mechanism. The study found that consumers are willing to pay a premium for fortified maize variety, and the information on the nutritional quality played a pivotal role in influencing participants' WTP. Other studies that use experimental mechanisms to estimate participants' WTP for different seed varieties are Corrigan et al. (2009) on consumer demand for genetically modified golden rice and Oparine et al. (2015) on consumer willingness to pay for biofortified yellow cassava varieties in Nigeria.

A major limitation of these studies is that while they look at the tradeoff consumers make between a positive attribute (fortification) and a negative attribute (unorthodox color), they fail to look at the tradeoff producers have to make among production traits such as yield, plant cycle length, plant height, and grain color (Waldman et al., 2014). Focusing only on either production or consumption traits could lead to bias, as most of the households in developing countries are involved in both production and consumption. Dalton (2004) revealed in his study that evaluating

only on production characteristics leads to 19.1% of all rice varieties miscategorized as inferior among rice farmers in West Africa.

Later studies focus on both consumption and production traits or only on production traits. One study that combined both consumption and production traits is Waldman et al. (2014). The study combined participatory crop trials and experimental mechanisms to estimate farmer preferences for improved varieties of common bean in Rwanda. The study concluded that mechanisms revealed farmer preferences more accurately than stated nonbinding rankings. It also found that farmers valued the intercrop performance of new varieties more than monocrop performance.

However, although these past studies pay significant attention to identifying farmers' or consumers' preferences on attributes and examining their willingness to pay a premium for the varieties with different genetic traits, the quality attributes were implicitly held constant or were not considered as attributes (Maredia et al., 2019). Thus, a gap in the literature that this study attempts to fill is the understanding of farmers' demand for different qualities of the same variety with the same genetic trait, i.e., farmers willingness to pay (WTP) for certified seeds relative to retained seeds (grains), holding the variety or genetic traits constant. Recent studies on seed demand by Maredia et al. (2019), Bartle (2019), and Posey (2018) have addressed this gap using experimental mechanisms.

Maredia et al. (2019) and Posey (2018) used double-blind field experiments (FE) and experimental mechanisms to investigate farmers' willingness to pay for quality legume seeds of different quality traits, i.e., certified seeds, quality declared seeds (QDS), and recycled seeds (grains from previous harvest) in Tanzania and Ghana (Maredia et al. study) and Nicaragua (Posey

study), holding the variety constant. These studies indicate that differences in farmers' WTP are highly correlated with differences in their perceived quality.

Bartle (2019) also used experimental mechanisms in Kenya to measure framers' willingness to pay for potato seed products from three different systems—the formal, the semiformal, and the informal systems. The study indicated that farmers value seed products that have the highest quality. In particular, farmers were willing to pay most for the certified seeds from the formal sector, followed by clean seeds from the semi-formal and recycled seeds from the informal system.

This study builds on the recent studies focused on understanding farmers' WTP for seed quality. It contributes to this nascent literature in three ways. First, this study will fill the gap in literature by documenting farmers' demand for different qualities of the seeds, controlling the variety constant.

Secondly, the study will empirically test the viability of the local seed production. In recent years, the development community, i.e., NGO and donors, and research institutions have promoted the seed production and dissemination activities at the local-level for self-pollinating crops (David, 2004; Wiggins and Cromwell, 1995). The local-level seed production has certain advantages in seed production and dissemination—it can produce cheaper, provide greater geographic and social reach, cater to regionally specific varietal preferences, and be more accountable for its product to the community (Rubyogo et al., 2007). Despite its advantages and promoted as means to improve the use of quality seeds, the local seed production for quality seeds has rarely been studied in the perspective of farmers' demand, i.e., farmers' willingness to pay for the quality seeds from the local seed system compared to the quality seeds from the formal system, holding the variety constant.

Finally, the study will contribute to the literature by studying the relationship between farmers' WTP across three seed system—the formal, semi-formal, and the informal system, and the quality signaling information such as packaging, branding/labeling, traceability information, and lab results. The past studies on the effects of the branding/labeling and certification on farmers' WTP focus on the higher-quality products such as fruits and baby food in developing (Masters and Sanogo, 2002; Birol et al., 2015) and various foodstuffs in developed countries (Barsky et al., 2003; Lusk et al., 2003; Enneking, 2004; Roe and Sheldon, 2007). However, the studies on the effects of the quality signaling information on WTP of quality seeds is rare except only the recent studies by Banerji et al. (2016). Banerji et al. (2016) tests the branding/labeling and certification on farmers' WTP for high iron pearl millet in India. Thus, this study will contribute to the nascent literature by examining the quality signaling effects on farmers' WTP from different seed systems.

Chapter 3: Research Methods and Empirical Strategy

3.1: Valuation Methods

Market prices usually reflect consumers' valuation and willingness to pay for products. However, this is not an option when we want to measure the valuation and demand for new products or for existing products with added attributes that are not present in the market. The understanding of individuals' valuation and preferences placed on non-market products, i.e., willingness to pay (WTP) is important so that we can measure the welfare effects of technological innovation, forecast new product success, carry out cost-benefit analysis, and understand consumer choices and behaviors (Lusk and Shogren, 2007).

There are several elicitation methods that have been used in the literature to investigate consumer or producer willingness to pay for novel goods or changes in the qualities or attributes of existing goods. One of the popular methods is the stated preference (i.e., contingent valuation method). The stated preference method is a survey-based technique to elicit valuation. Some of the contingent valuations are dichotomous choice questions and choice-based conjoint analysis (Lusk and Hudson, 2004).

One of the primary issues related to the elicitation technique is the question of incentive compatibility (Lusk and Hudson, 2004). An elicitation mechanism is assumed to be incentive-compatible if the preferences or valuation are truthfully revealed. Many valuation studies are associated with asking hypothetical questions or creating a hypothetical context so people might respond differently in the studies from real context, i.e., overstating or understating the value of a product.

Hypothetical bias is a significant problem in valuation and demand studies that use contingent valuation estimates (Carson, Groves and Machina, 1999). For instance, List and Gallet

did a Meta analysis of twenty-nine studies and found that on average subjects overstated their valuations about three times in hypothetical settings.

Another common elicitation method is revealed preference method, which uses existing market data to analyze implicit values to elicit valuations (Lusk and Shogren, 2007). The disadvantage of the revealed preference method is that the valuation estimates are indirect and require assumptions to interpret observed behaviors into valuations.

Experimental mechanisms are increasingly used method in elicitation of nonmarket valuation. They are usually conducted in one or two ways. The first strategy is called the endow-and-upgrade approach in which the participants are given one good and then they are offered a chance to bid to upgrade the product of interest (Corrigan and Rousu, 2006). In the second approach, participants bid simultaneously on one or more products and their bids are compared with a random price or a second highest price to determine who gets to purchase a product for which bids were placed (Lusk and Shogren, 2007).

Experimental mechanisms have certain advantages over other elicitation methods because by design, they are incentive compatible as well as estimation of consumers' demand and valuations are direct and easy. Experimental mechanisms are incentive-compatible because they are conducted in a non-hypothetical context in which people are put in a well-simulated market environment with real money, real goods, and market information (Lusk and Shorgen, 2007). Besides, it is easier to measure the willingness-to-pay values at an individual level as each person submits a bid equal to his/her value for the product. In other elicitation methods such as discrete choice experiments, probability valuations are estimated using statistical models and based on assumptions about utility functions.

There are several experimental mechanism such as the English mechanism, Vickrey or the second price mechanism, the Becker-Degroot-Marschak (BDM), and the random Nth price mechanism that are theoretically proven as incentive compatible (Lusk, 2003). Majority of past research studies have used a Vickrey mechanism (Umberger and Feuz, 2004). In the Vickrey or second price mechanism, each consumer submits sealed bids and the individual with the highest bid wins, but pays for the second highest bid amount for the good (Vickrey, 1961; Lusk et al., 2004). These types can only be conducted in a group setting.

Another popular value elicitation method is the Becker-Degroot-Marschak (BDM) mechanism in which participants do not bid against each other but against a random price (Becker, DeGroot, and Marschak, 1964). This means that every subject in the experiment has a chance to win. If the bid is greater than or equal to the randomly drawn price, the bidder wins and purchases the product at the randomly drawn price (Lusk and Shogren, 2007). Another advantage of BDM is that it could be conducted at an individual level or in a group setting.

Despite its advantages over other elicitation methods, experimental mechanisms do have some shortcomings. For instance, the products used in the experiments are hypothetical and participants are often not familiar with the products (Breidert et al., 2006). Besides, the demand or the value that is estimated from these experiments are a snapshot of a person's WTP at one particular point in time.

Another challenge inherent in the experimental mechanisms is the distribution of initial endowment which could distort optimal bidding behavior (Corrigan and Rousu, 2006). Participation fees can relieve cash constraint and allow participants to bid without that constraint at the time of bidding. However, the disadvantage of the providing participation fees is that farmers may not perceive the participation fee as their own, which may compel them to make riskier

decisions and may not take into consideration trade-offs they normally consider in a real-life situation (List and Rondeau, 2003). Empirically, the literature has tested and found some mixed evidence on the provision of endowments, and it still remains widely used in mechanism experiments, especially when the major focus is to estimate incremental value (or premium) a participant is willing to pay for a new product relative to a base product whose market value is well established (Loureiro et al., 2003).

For this study, we used the BDM mechanism because it is one of the incentive-compatible elicitation methods and it was simpler and convenient to implement in rural settings. We also chose to give a participation fee to participants. The reason for giving a participation fee was that the mechanisms took place at a central location in the village and not at farmers' residences. This means farmers may not have cash in hand when they arrived at the study site and this could impact their willingness to participate in the BDM mechanisms. In addition, we hoped that participation fees would increase participants' focus on the task at hand by reducing the effect of field substitutes or product substitutes found outside of the experiments (Lusk and Shogren, 2007). The details of the experiment design are discussed next in the methodology section.

3.2: Research Methods

This study tries to understand the demand for seed of chickpea and green gram using incentivized bidding experiments. These experiments were conducted in 11 villages with a total of 512 farmers from the MyinMu and KyaukSe townships in the Central Dry Zone region of Myanmar. For one of the crops—i.e., green gram, I also conducted a cost of production survey with 12 local seed producers who produced green gram seeds in the 2018 pre-monsoon season (around from March to May). Most of these farmers were also planning to produce chickpea seed in the 2019 winter season, which was after all the field work for this study was concluded. Thus, the supply side

analysis of quality seed production presented in this study is based on data for only green gram and does not include chickpea.

As mentioned in the background section in chapter 2, the private sector's involvement in the legume seed production in Myanmar is very limited. Currently, there are no private companies producing legume seeds (MoALI, 2016). Moreover, community-based seed production (CBSP) has yet to become popular in Myanmar. So, we do not have many local farmers in the market to interview for our supply-side survey. Even though the sample size is quite small, we should be able to at least understand the cost structure of these local seed producers, so as to compare the cost with farmers' WTP derived from the mechanism experiments.

Demand Side: Experimental Bidding Mechanisms

We conducted our experiments in MyinMu and KyaukSe townships of the Central Dry Zone. We chose the Central Dry Zone because it is the main production region for green gram and chickpeas. In 2015-2016, about 60% and 96% of total cultivated areas for green gram and chickpea, respectively, were located in the Central Dry Zone.[5] This study builds on the 2018 household survey conducted by Michigan State University's Food Security Policy Project to estimate farmer demand and adoption of quality seeds for eight crops, including green gram and chickpea.

This survey was conducted in collaboration with the Wageningen University, the Ministry of Agriculture, Livestock and Irrigation of Myanmar, Centre for Economic and Social

[5] In 2015-2016, green gram was cultivated around total 2.9 million acres in the entire country. The Central Dry Zone (Sagaing, Magway, and Mandalay regions) cover about 1.7 million acres (CSO, 2016). For the same year, the total chickpeas cultivated area for the entire country was around 920,482 acres. Of the total, 883,607 acres of total sown land was in the Central Dry Zone (Sagaing, Magway, and Mandalay regions) (CSO, 2016).

Development, and the International Food Policy Research Institute, and covered 1383 households across five townships in the central dry zone. From this sample of household surveys, we identified the main townships that reported the highest number of households growing chickpea and green gram, using the listing information collected prior the 2018 survey. From this list, we selected Kyaukse and Myinmu townships in Mandalay region to conduct this study because both green gram and chickpea are cultivated in these two townships, and logistically, it was convenient to have these two townships located next to each other.

In the second stage, using household listings from the 2018 survey, I identified villages where there were more than 20 farmers who were growing either green gram or chickpeas. I selected eleven villages that met this criterion. I then contacted the village head in advance and got his concurrence to conduct the study in that village. All the villages selected had at least 20 farmers who grew either chickpea or green gram or both. Within given villages, with the help of the village head, I randomly invited 20-35 farmers to participate in our experiments, which was conducted in a group setting at a central location such as a temple, school or in the courtyard of the village head's house. When participants arrived at the experiment sites, some screening questions were asked to make sure the participants were involved in green gram or chickpea farming and had some experience buying seeds. In total 258 farmers for green gram and 254 farmers for chickpea participated in the bidding mechanism. The sample of farmers in this study are similar in characteristics as the farmers in a larger representative household survey (sample=1383) conducted by MSU and Wageningen University in 2018 in the Central Dry Zone region (See Table 4.1 and 4.2, and Table A-3 and A-4).

Supply Side: Cost of Production Survey

Recently in Myanmar, there are some ongoing efforts by non-profit organizations (NGO) to build community-based seed production system by training farmers to produce certified seeds. The Integrated Seed System Development (ISSD) program of Wageningen University is one of the NGOs active in this effort in the Dry Zone region. ISSD provides registered seeds acquired from the Department of Agriculture (DOA) to their trained local seed producers/farmers and provides technical assistance on seed production, packaging, and marketing aspects. We conducted a cost of production survey with 12 green gram seed producing farmers who were working with ISSD in the selected townships.

The purpose of this survey was to collect data to seed producers' practices, input use, and other measures they have to take to ensure seed quality to help estimate the cost of producing green gram certified seeds. The seed producing farmers included in the survey had previous experience working with DoA to multiply certified seeds; however, this was their first year working with ISSD. Even though it might be early to tell long-term results of the local seed production, I should be able to at least understand whether this kind of grass-roots level seed production is cost-effective to meet the demand of seed by local farmers.

3.3: Experimental Design and Methodology

For demand analysis, I used the Becker-Degroot-Marschak (BDM) mechanism and structured survey questionnaires to learn about individual and household characteristics, crop production practices, previous seed adoption experiences, and variety preferences. Each experiment included two rounds of bids. I displayed five seed products in the first round and eight seed products in the second round. A summary of the experimental design with the list of products and type of information provided in each round is shown in Table 3.1.

Overview of Bidding Experiments

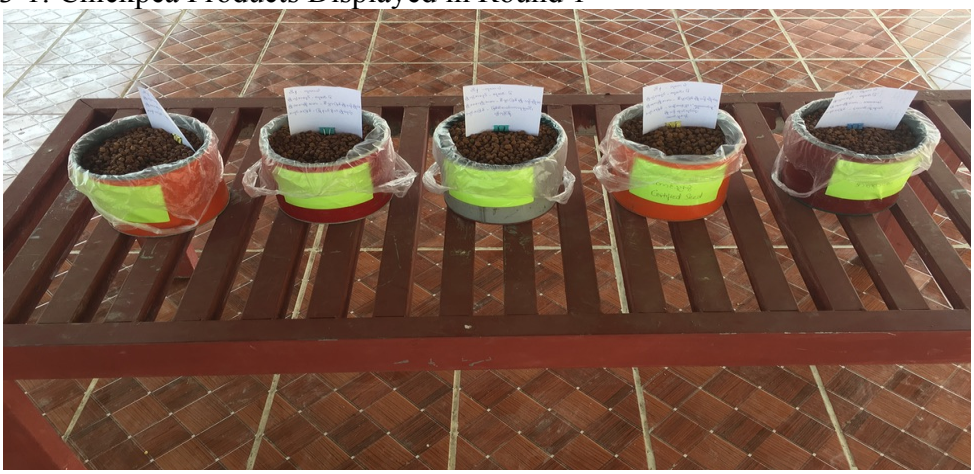
In round 1, the experiment included two grain items and three certified seed (CS) items. Two grain products used in the experiments were: 1) grain produced by a farmer; and 2) grain purchased from the market. These two seed categories represent the informal seed system and are the most common sources that farmers currently rely upon. The three certified seed products included in the experiment were: 3) certified seeds from the township's Department of Agriculture (DOA) offices; 4) certified seeds from a private company; and 5) certified seeds from a local seed producer/farmer (See Table 3.1).

Seeds used for displaying these five products were procured by the researcher from following three sources—products 1 and 2 from a grain producing farmer in one of the non-experiment villages located in Madaya township, product 3 from the Mandalay township's DOA office, and products 4 and 5 from a local seed producing farmer supported by the Integrated Seed Sector Development (ISSD) project.

Currently, there is no private company providing quality seeds for either green gram or chickpea in the market. So, we used the seeds procured from a local seed producer to display as the seed products representing company seed (i.e., product 4).

Since products 1 and 2 were essentially from the same source and products 4 and 5 were also from the same source, what the experiment is designed to show is the effect of the quality signaling conveyed in the information about the source of seeds (i.e., a grain farmer, grain market, DOA, private company, and a local seed producer) (See Figure 3.1 and Figure 3.2 for items in round 1).

Figure 3-1: Chickpea Products Displayed in Round 1



Source: Author

Figure 3-2: Green Gram Products Displayed in Round 1

Source: Author

For round 2, respondents were shown the same five products as in Round 1 with incremental information on seed sources (i.e., exact brand name and location) (Table 3.1). In addition, certified seeds were shown as packaged seeds in two versions-- one had no information on seed quality and the other had a blank table with a list of seed quality attributes that can be objectively measured through lab testing and provided by the government as part of the seed certification process.

The government lab test results signal quality assurance. The lab results include the name of the supplier, the type of variety, contact information of the supplier, and the township DOA which signs the document. Most importantly, the document comes with a table that describes the quality of seeds in terms of seven attributes, i.e., the percentages of seed purity, germination, moisture, inner matter, other seeds, weed seeds, and red seeds.

For the three products whose package included this blank table of lab test result information, I first explained to the participants the type of information the seed package would potentially include and what such labeling implies in terms of seed quality. For example, I explained the seven seed attributes that would be mentioned in the lab result and how to interpret the information, i.e., for instance, higher percentage of purity and higher percentage of germination rate means better quality.

When I displayed the products with lab result labeling, I presented the blank table with the type of information a lab report would contain but not the actual results (See Figure 3.5). This was done to avoid the effects of the lab report itself on farmers' WTP. What this experiment was designed to assess was the value of labeling seed package with information that signals quality, rather than the effect of the information itself. When explaining about the three products that came with lab result labeling, I informed the participants that these products were tested by the government seed testing lab and I had the lab results, which would be provided to farmers if that product was selected as binding product for sale (see more discussion on the selection of products for sale below). Figure 3.5 shows the pictures of what the packaging of the seed products in Round 2 (with and without lab results) looked like.

Thus, the second round included a total of eight products (See Figure 3.3 and Figure 3.4). They are: 1) bulk grains from a farmer with additional information on the name and location of

the farmer; 2) bulk grains from the market with additional information on the location; 3) packaged certified seeds from the government with information on the name of the township DOA, logo, contact information, but no lab test result table; 4) packaged certified seeds from the government with information on the name of the township DOA, logo, contact information, with lab test result table included on the package (but not the results); 5) packaged certified seeds from a private company with information on the name of the company, logo, contact information, but no lab test result table; 6) packaged certified seeds from a private company with information on the name of the company, logo, contact information, with lab test result table included on the package (but not the results); 7) packaged certified seeds from a local seed producer with information on the name of the seed producer, logo, contact information, but no lab test result; 8) packaged certified seeds from a local seed producer with information on the name of the seed producer, logo, contact information, with lab test result table included on the package (but not the results) (See Table 3.1).

To make our presentation of results clear, I refer to the three information treatments as treatment 1 (corresponding to Round 1), treatment 21 (corresponding to Round 2, without lab results), and treatment 22 (corresponding to Round 2, with lab results) in the rest of this paper.

Figure 3-3: Green Gram Products Displayed in Round 2

Source: Author

Figure 3-4: Author Explaining Green Gram Products Displayed in Round 2

Source: Author

Figure 3-5: Product without a lab test result table (Left-hand) and with a lab test result table (Right-hand)

Source: Author

In Myanmar, farmers normally buy seeds or sell their crops in units of pyi.[6] Therefore, all seed products were displayed in one pyi baskets in Round 1 and one pyi packages in Round 2 (See Table 3.1). Likewise, farmers were asked to bid and make a purchase of seed products in term of one pyi. Since seeds are normally sold and purchased in bulk, the packaging of certified seeds included in Round 2 is hypothetical and not something currently present in the market. Of course, the logo for the seed from DOA was the actual logo of the DOA, but the seed packages (including the name, logo, branding) for the seeds from the private company and the local farmer producer were designed by the researcher specifically for the experiment.

All seed products in the respective round were displayed on a table placed in front of the group of participants (see Figure 3.6). The products were properly labeled providing all the treatment information intended for each round. For all the experiments, I used the same variety called Yezin 14 for green gram and Yezin 6 for chickpea.

[6] Pyi is one of Myanmar's common trading measurement units for agricultural products. One pyi of green gram is equal to 2.04 kg and one pyi of chickpeas is 1.96 kg.

Figure 3-6: Seed Products in Round 1 Displayed on the Table

Source: Author

Each participant received a participation fee equal to MMK 8,000 (approximately $5) for green gram and MMK 7,000 (approximately $4.5) for chickpea.[7] This also served as an 'endowment' to avoid the effect of farmers not having cash at hand on their bids. The participation fee given to the farmers was about double the price of one pyi of certified seed paid by the researchers in procuring the seed for the experiments (i.e., I paid MMK 4,000 for one pyi of green gram and MMK 3,500 for one pyi of chickpea seeds). The reason for giving farmers an endowment double the market price, was to avoid potential upper-level truncation in WTP prices.

[7] 1$ is approximately equivalent to MMK 1,500.

Even though farmers were to bid all products displayed in each round, only one product in both rounds was randomly selected at the end for sale. By doing so, I can also avoid participants distributing their purchasing power across products.

To avoid an order bias on farmers' bids for different products, we had prepared four sets of bidding sheets. Products were arranged (i.e., displayed) and listed in different order across the two rounds and across the four sets. For a given village, one set was randomly selected and implemented for all the participants. In a given village, the products and their treatment information labels were arranged and displayed according to the order it appeared in the bidding sheet randomly selected for that village. Likewise, in the overlapping villages, where I conducted bidding experiment mechanisms for both crops twice to the same group of farmers, I also rotated the crop order.

On the bidding sheets, farmers were allowed to bid from zero to as much as they would like to bid with an increment of 50 kyats (approximately three cents) to express their maximum willingness to pay. All Myanmar currency notes start at one kyat. However, I asked the farmers to bid with an increasing increment of 50 kyats because it is hard to find the currency notes or coins lower than 50 kyats. Moreover, the sale price of most of the products start at minimum 50 kyats in Myanmar.

Since I are not allowing bids lower than zero, it is likely that I might have a censoring issue if our data has zero values as WTP because participants might transform their negative WTP to WTP of zero (Lusk and Shogren, 2007). To test if there was any upper or lower level censoring in our data, I ran the Tobit model and found that only a negligible number of observations were censored (See Table A-1 and A-2).

Research Questions and Hypotheses

From round 1, I expect to answer the following research question.

1) Does farmers' willingness to pay differ between certified seeds and recycled seeds?

2) Does farmers' willingness to pay differ across quality signaling information reflected in seed sources—i.e., grain from the market, grain saved on farm, CS from the government, CS from the seed company, and CS from the local seed producer?

From the second round, I expect to study following research questions.

1) Does packaging, branding, and traceability information, i.e., supplier name and contact details have any effect on farmers' willingness to pay a premium?

2) Does the quality assurance information on seed quality lab result alter farmers' WTP a premium?

From Round 1, I hypothesize that the seed type (i.e., grain vs. certified seed) and the seed source (i.e., other farmer, market, government, farmer producer, or the private company), would signal quality, and therefore farmers' WTP would be different across the seed type and seed sources. In a well-developed market system, packaging, which includes the brand name, logo, and traceability information (such as name and contact information), signals the quality of products. Therefore, I hypothesize that seeds sold in packages with this type of information would signal quality, and thus increase farmers' willingness to pay for seed. Similarly, in Myanmar, the government is the only entity that does seed testing and certifies seed quality. Therefore, I also hypothesize that the packaged seed with the label of the government lab test information would increase the trust of the farmers in the seed quality and thus their WTP.

Detailed Procedure of Bidding Experiments

The experiments were conducted either by the author or a trained researcher in the local language. The experimenter followed a script to make sure there was consistency in the information shared across all the villages (See Appendix B for the study script). The procedure of the experiment was as follows.

Before Round 1

First, I started the experiment by registering the farmers and giving them their ID# which was used to track their bidding sheets and survey questionnaires. Second, I explained to them as a group the purpose of bringing them together and what the BDM mechanism entailed. This included the general purpose of the study, the concept of an 'endowment' that farmers would receive as participation fees, the process of completing the bidding sheets, the random selection of rounds, the random selection of a product, and the process of selecting a random price (See Figures 3.7 and 3.8). Then, enumerators distributed the consent statements, received verbal consent agreements from the participants, and started the first two sections of the structured survey on the participants' characteristics and their previous experiences with different seed source in the experiments.

Third, I conducted a practice mechanism using a toothpaste to familiarize participants with the BDM mechanism. I informed participants that they would receive an endowment of 500 MMK (approximately 33 cents) as a participation fee for this practice mechanism. The product selected for the practice round was a toothpaste, whose market value was about 250 MMK (approximately 16 cents).

Like the seed experiments to come, participants could bid from 0 to as much as they wanted with an increment of 50 kyats. Bids were collected for the practice BDM, and then a random price

was drawn to decide the purchase price. Participants purchased the product if their bid was equal to or greater than the random price, and paid the random price. The random price was programmed to range from 0 to 500 with an increment of 50 kyats. However, this range was not disclosed to the participants to avoid any price anchoring effects. Any questions about the actual mechanism rules and the process were answered at this time before proceeding to the seed bidding mechanism.

Table 3-1: Experimental Mechanism Design

	Round 1	Round 2	
Information Treatment	Seed type and source (Treatment 1)	Additional information on source of seed (e.g., name and location), branding, packaging, and labeling	
		Bulk or Packaged seed comes without seed quality lab test label (Treatment 21)	Packaged seed comes with seed quality lab test label (Treatment 22)
Products (i.e., information about the product relayed to participants) \a	P1: grain produced by a farmer; sold in bulk	· grain produced by farmer U Myit Kyaw from Nat Kan Village, Magway township; sold in bulk; available without the lab result	
	P2: grain purchased from the local market; sold in bulk	· grain purchased in the local market Yan Pal Zay in Magway township; sold in bulk; available without the lab result	
	P3: certified seed from township DOA; sold in bulk	· Packaged certified seed from Mandalay township DOA available without the lab result	· Packaged certified seed from Mandalay township DOA available with the lab result
	P4: certified seed from the company; sold in bulk	· Packaged certified seed from the company Mya Sein Lal Yar located in Yangon, available without lab result	· Packaged certified seed from the company Mya Sein Lal Yar located in Yangon available with the lab result
	P5: certified seed from the local seed producer/farmer; sold in bulk	· Packaged certified seed from the local seed producers, Shwe Taung Thu, from Ta Mway Village, Magway Township, available without lab result	· Certified seed from the local seed producers, Shwe Taung Thu, from Ta Mway Village, Magway Township available with the lab result
Total Number of Products	5 Products	8 Products	

\a All seed products in both rounds were displayed in the same quantity (i.e., 1 pyi).

Figure 3-7: Author Explaining the Process of Selecting a Random Price

Source: Author

Figure 3-8: Author Explaining the BDM Procedure

Source: Author

Round 1

After the practice rounds, I started our first round of seed mechanism by describing each of the five seed products. Then, I handed out the bidding sheets and invited participants to come to the front to inspect the seed products displayed at the table (See figure 3.9 and 3.10). Then, the administrator asked participants to write down their maximum willingness to pay for each product on the bidding sheet. Enumerators walked around the room to help any participant who had trouble with recording their bids and also to make sure no one was communicating with others. Any questions raised at this time were answered only according to the script in order to avoid any bias and influence on farmers' choices (See Appendix 10 for the study script). After everyone completed his/her bidding sheet, enumerators collected them and handed out the quality perception question form. After the participants finished rating the quality for the products in round 1, the enumerator collected the forms. This completed the first round of the mechanisms.

Figure 3-9: Participants Inspecting the Round 1 Products

Source: Author

Figure 3-10: Participants Inspecting the Round 1 Products and Bidding their WTP

Source: Author

Figure 3-11: Participants Bidding their WTP

Source: Author

Round 2

After enumerators finished collecting the bidding sheets from the first round, I continued with the second round. I displayed the eight items as described earlier on the table (See Figure 3.12). The eight products were displayed in different order than before. The procedure of the round was, as usual, providing information first on each product, giving out the bidding sheets to all the farmers, then inviting them to come forward and inspect the products, and collecting the bids (See Figure 3.13). As in round 1, enumerators handed out the quality perception survey form after the bidding. After the participants finished rating the quality for the products in round 1, the enumerator collected the forms. This completed the second round of the mechanisms.

Figure 3-12: Author Explaining About Round 2 Products

Source: Author

Figure 3-13: Participants Inspecting the Round 2 Products

Source: Author

Selecting the binding rounds, products for sale, and random price

After the second round, the administrator asked a participant to flip a coin to decide which Round would be binding (i.e., Round 1 or 2). Then for the binding round, the administrator revealed which product among all displayed products for that round was selected for the mechanism. The administrator informed the participants that the binding product for that round was already randomly selected due to logistical challenges of carrying a large amount of seeds to different villages.[8] After the binding product was determined, I asked a participant to come forward and press a button on the computer to draw a number that will determine the random price for the binding product (See figure 3.14, 3.15 and 3.16) for random price selection). The random price

[8] The binding product pre-selected in the experiments were one of the highest quality seed products (i.e., certified seed from the DOA or the local seed producer). For ethical reasons, grain products were not selected as binding products in any villages.

was programmed to range from 0 to 7,000 for chickpea and 0 to 8,000 for green gram with an increment of 50 kyats. This predetermined price range, however, was not revealed to farmers.

Any farmer whose bid for the selected product in the selected round was greater than or equal to the random price purchased one pyi of the product at the random price and anyone who bid lower than a random price did not purchase the seeds. In practice, what this means is that anyone who did not purchase the seeds received full amount of their participation fees. Those that purchased the seeds received one pyi of seeds and the difference between their participation fee and the random price. This completed the mechanism part of the group session, and the enumerators continued conducting the rest of the survey.

Figure 3-14: Participant Selecting the Random Price (example 1)

Source: Author

Figure 3-15: Participant Selecting the Random Price (example 2)

Source: Author

Figure 0-16: Presenting the Selected Random Price to the Participants

Source: Author

3.4: Empirical Methods

In our experiments, a single farmer submitted bids for multiple products in a single round as well as multiple bids for the same product across rounds. Therefore, our data structure is similar to a panel data format with repeated observations for each participant across rounds. This data structure allows us to use individual-specific fixed effects or random effects model to estimate the information and product treatment effects.

Such fixed or random effects model addresses the issue of bias in estimated coefficients that can come from unobserved, unit-specific, and time-invariant factors which might not be a problem in our experiments since all our data points are for one time period only. Nonetheless, we can use the fixed effects or random effects to control for participants' unobservable characteristics to have the better estimators.

The difference between the fixed effects model and the random effects model is the difference in key assumptions. Under the fixed effects model, we assume that the unobservable heterogeneity is correlated with any of the regressors in the model, so potential bias and inconsistencies are likely to present among our estimators. The fixed effect model can be easily attained by including dummy variables for each individual, treating each unit as a parameter. The problem with the fixed effect model is that the estimates are inefficient if the unobservable heterogeneity is not correlated with regressors.

The random effects model assumes that the unobserved heterogeneity is not correlated with included regressors but individual-specific terms are part of the disturbance term. The composite disturbance term means the normal OLS is not appropriate for estimation. If the unobserved heterogeneity is correlated with any of the regressors, the random effects model is inconsistent. Otherwise, it is more efficient than the fixed effects model. I run a Hausman test to determine

whether the fixed or random effects specification is appropriate. It tests whether the individual-specific error term is uncorrelated with the included regressors. The test reveals that the random effects model is more appropriate. [9]

I can use the following random effects model to estimate the effects of the independent variables on farmers' WTPs.

Model 1:

$$WTP_{itj} = \alpha + \beta_1 Treat_t + \beta_2\ Item_j + \beta_3 Treat_t \times Item_j + \beta_4\ X_{ij} + \beta_5 W_{ij} + u_i + \varepsilon_{itj}$$

where WTP_{itj} is the willingness to pay by i -th farmer for product j ex post of information treatment t; $Treat_t$ is the information treatment variable with t=1, 21, and 22, $Item_j$ is the product j ; $Treat_t \times Item_j$ is the information treatment by product interaction terms which will measure the incremental effects of additional information for each product; X_{ij} is farmer's prior experiences with the seed product j ; W_{ij} is the vector of quality ratings perceived by farmers, u_i is the farmer random effects, and ε_{itj} is the residual term that is not captured by model 1. β_1, β_2, β_3, β_4 are the coefficients that will estimate the effects of independent variables on WTPs. Since the number of products vary between information treatment 1, 21 and 22, Model 1 is estimated for the following pairs of treatment and products—Treatment 1 and 21 for products 1, 2, 3 (without seed test label), 4 (without seed test label), and 5 (without seed test label); Treatment 1 and 22 for product 3, 4, 5 (with seed test label); and Treatment 21 (without seed test label) and 22 (with seed test label) for products 3, 4, and 5.

[9] For chickpea, Prob>chi2=0.9350 (Hausman test for all rounds).
For Greengram, Prob>chi2=0.9989 (Hausman test for all rounds).
For individual rounds comparison, the test results also show that random effect model is more appropriate most of the times.

Previous studies of the technology adoptions have shown that household characteristics are important factors in determining technology adoption decisions. Since purchase of quality seed is equivalent to adoption decision of a new technology, it is expected that those characteristics are also likely to affect participants' WTP. In order to measure their effects on the dependent variable (WTP), in Model 2, I include the Z_i which is a vector of individual's and household's characteristics of i-th farmer instead of controlling for individual random effects.

Model 2:

$$WTP_{itj} = \alpha + \beta_1 Treat_t + \beta_2 Item_j + \beta_3 Treat_t \times Item_j + \beta_4 X_{ij} + \beta_5 W_{ij} + \beta_6 Z_i + \varepsilon_{itj}$$

Since our experiments were conducted at the village level with a group of 20 to 30 farmers, it is likely that the observations within each experiment are not independently and identically distributed but are correlated among units within each cluster. This correlation could lead to an incorrect conclusion in our hypothesis testing. Therefore, I account for this potential problem by clustering the standard errors at the experiment location level using the bootstrapping method.

Chapter 4: Results-Descriptive Analysis

4.1: Characteristics of Participants

Individual and household characteristics are important factors that determine technology adoption decisions as shown by many studies in the literature reviewed in Chapter 2. Table 4.1 shows the summary statistics of participants' characteristics for both chickpea and gram gram experiment mechanisms.

On average farmers share similar characteristics across both the crops, which is not surprising as some of the experiments were held in the same village and some of the farmers were growing both the crops and thus participated in both the experiments. All the participants in the study were main decision makers for crop cultivation, and slightly more than half of the participants were identified as the heads of their households (see Table 4.1). The experiments for both crops included an equal number of males and females. The average age of participants was around 50 years, and almost all of them knew how to read and write. The average formal educational attainment of a participant farmer was grade 5.

On average, participants had more experience growing chickpea than green gram, showing 14 years of average chickpea growing experience and seven years for green gram (See Table 4.1). Participants had little training related to crop cultivation and seed quality. This figure is expected as the extension service in Myanmar is weak.

Likewise, only a small number of farmers are members of a farmer group. Again, this can be expected as civil association is weak in Myanmar. Only a quarter of the sample of participants of both crops identified themselves as early adopters of technology.

Table 4-1: Summary Statistics of Participants' Characteristics

	Chickpea			Green Gram		
	N	Mean	SD	N	Mean	SD
1=Main Decision Maker for cultivation	254	1.00	0	258	1.00	0
1=Male	254	0.54	0.49	258	0.51	0.50
Average Age	243	48.00	11.62	251	49.00	11.80
1= Know read and write	254	0.99	0.11	258	0.99	0.09
Highest level of educational attained	254	4.87	2.97	258	4.84	2.92
1= Household Head	253	0.59	0.49	258	0.55	0.50
# of years of growing a given crop	236	14.17	13.00	253	7.07	6.15
1= Member of Farmer Groups	253	0.06	0.22	256	0.05	0.22
1=Received training in crop cultivation	254	0.03	0.16	257	0.05	0.21
1=Received training in seed quality	253	0.02	0.13	256	0.02	0.14
1=Early Adopter (self-reported)	251	0.24	0.43	247	0.25	0.43

Source: Farmer willingness to pay for quality seed survey, Myanmar (2018)

Table 4.2 shows the characteristics of participants' households. The average size of a household in the study area is 4 people. Almost all farmers in the study area owned land. Most of them are small-scale farmers, owning an average of 6 acres of agricultural land. They planned to allocate slightly more than one-third of their agricultural land for chickpea or green gram cultivation in the coming season. Most of the villages in the experiments were located in irrigated areas. Majority of households could access irrigation for both crops. 72% for chickpea and 88% for green gram respectively had access to irrigation for both crops.

As indicated by the distance variables, study villages were located pretty close to the market, and had good infrastructure. On average, the study villages were about 25 minutes away from the nearest market by motorcycle and about 2 miles away from the paved road. Again, these

factors are important to take into consideration because they imply different access to input and output markets, which can influence farmers' WTP for seed

Table 4.2 also shows farming practices of households in the study area. On average a household produced about 11 baskets (approximately 345 kg) per acre of chickpea and 12 baskets (approximately 392 kg) per acre of green gram per year.[10] They used 16 pyi (about 32 kg) of chickpea seed per acre whereas green gram required four pyi (about 8 kg) of seed to cultivate one acre of land. Almost all the harvested grains for both these crops were sold, showing 91% for chickpea and 94% for green gram. Slightly more than half of the households in the sample purchased seeds from outside sources. This is true for both crops. Of all households which purchased seed from other sources, they spent only a small share of total production cost for seed, i.e., 12% for chickpea and 5% for green gram. About 20% of households for each crop also sold their harvested grain as seed.

[10] 1 pyi of green gram is equivalent to 2.04 kg and 1 pyi of chick pea is 1.96 kg.

Table 4-2: Summary Statistics of Households' Characteristics

	Chickpea			Green Gram		
	N	Mean	SD	N	Mean	SD
Households Size	253	4.30	1.50	256	4.30	1.50
1=Own agricultural land	250	0.99	0.11	248	0.99	0.09
Total agricultural land owned (in acres; including 0)	250	5.72	4.62	248	5.88	4.44
1=Planned to cultivate crop in upcoming season	238	0.99	0.11	255	0.99	0.06
Total area planned to cultivate in upcoming season (in acres; including 0)	238	2.90	2.35	255	2.22	1.49
1= have irrigation access in upcoming season	238	0.72	0.45	254	0.88	0.32
Total irrigated area in upcoming season (acres; including 0)	238	2.02	2.3	254	1.88	1.54
Total irrigated area in upcoming season (acres; excluding 0)	172	2.79	2.22	224	2.13	1.46
Distance to nearest market (in minutes by motorcycle)	254	23.50	13.32	257	23.82	13.95
Distance to nearest paved road (in miles)	253	2.44	6.50	255	2.26	6.42
Total Crop Production (baskets/acre)	254	10.85	5.17	258	11.75	6.19
Total Quantity of Seed used (pyi/acre)	252	16.22	7.88	254	4.26	1.79
% Harvest sold	254	0.91	0.17	258	0.94	0.16
1=Purchased Seed	254	0.55	0.50	258	0.66	0.48
% of total production cost devoted to seeds (1=100% devoted; including 0 for those who used saved seeds)	252	0.06	0.02	258	0.05	0.08
% of total production cost devoted to seeds (1=100% devoted; excluding 0 for those who used saved seeds)	139	0.12	0.20	169	0.07	0.09
1= sell chickpea/green gram seed	254	0.19	0.39	258	0.18	0.36

Source: Farmer willingness to pay for quality seed survey, Myanmar (2018)

4.2: Previous Experience with Seed from Different Sources

Prior experience in using seeds from different sources can determine farmers' familiarity with different types of seed and their ability to discern quality differences. Depending on the ability to discern quality differences, their WTP could be different. Table 4.3 shows percentages of participants who reported ever using seeds from a particular seed source. Not surprisingly, farmers have more experience using seeds from the informal sector (i.e., saved seed, seed from other farmers, and grain vendors in the market), whereas the experience with the formal sector (i.e., government, seed company and seed producers) is minimal. A majority of farmers reported using retained seeds, showing 74% for chickpea and 69% for green gram. Likewise, a majority of farmers had also used grain purchased from other farmers and grain obtained from the market.

Only a few percentages of farmers reported having used government seed (8% for chickpea and 12% for green gram). Similarly, the percentages of farmers who had ever used seed from the local producer and a private seed company are very small. Each category contributes only around 2-3% of the sample.

Table 4-3: Prior Seed Use Experience by Seed Source

Ever used following type of seed?	Chickpea (N=254)	Green Gram (N=258)
	%	%
Saved Seed	73.62	68.99
Seed from other grain producing farmers	53.54	61.24
Seed from grain vendors in the market	72.44	60.47
Government Seed	7.87	12.40
Seed from a local seed producer	1.57	2.33
Seed from a company	1.97	3.10

Source: Farmer willingness to pay for quality seed survey, Myanmar (2018)

For the previous season, participants planted on average, one variety for both crops (See Table 4.4.). About 87% of chickpea and 89% of green gram varieties that were planted in the

previous season in the sample were identified as improved varieties (See Table 4.4). However, only a small percentage of seeds, i.e., 11% for chickpea and 17% for green gram, were certified.

Table 4.4. also shows the information on the sources of seeds for varieties planted in the previous season. Majority of the seeds planted in the previous season were from the informal sector, with 95% chickpea seeds and 87% for green gram seeds in total either came from own harvest, neighboring farmers, or grain trader/market. Among the formal sources, the highest percentage of seeds of varieties planted in the previous season were accessed from the government (3% for chickpea and 5% for green gram). Almost no seed was purchased from the company or the local seed producers. This suggests that even though farmers self-report using improved varieties, most of them are not using quality seed (i.e., certified seed) but grain either retained from own harvest or purchased from other farmers or trader/market. Most of the farmers claimed that they were satisfied with the quality of seed they had planted in the previous season (See Table 4.4).

Table 4-4: Use of Improved Varieties and Seeds from Different Sources in the Previous Season (at Variety Level)

	Chickpea			Mung Bean		
	N	Mean	SD	N	Mean	SD
# of variety planted in last season	252	1.03	0.24	258	1.01	0.21
1=planted certified seed	266	0.11	0.31	262	0.17	0.37
1=planted improved variety	262	0.87	0.34	258	0.89	0.32
Seed Source						
1=Own Harvest	266	0.35	0.48	262	0.31	0.46
1=Neighbor	266	0.17	0.37	262	0.26	0.44
1=Market/trader	266	0.43	0.50	262	0.30	0.46
1=Agro-dealer	266	0.01	0.11	262	0.06	0.24
1=Government	266	0.03	0.16	262	0.05	0.22
1=Company	266	0.01	0.09	262	0.01	0.09
1=Local Seed Producer	266	0.01	0.09	262	0	0.06
1=Other	266	0	0	262	0.01	0.11
Level of Satisfaction with Seed Quality						
1=Very Dissatisfied	265	0.09	0.28	260	0.1	0.3
1=Neutral	265	0.2	0.4	260	0.22	0.41
1=Satisfied	265	0.71	0.45	260	0.69	0.46

Source: Farmer willingness to pay for quality seed survey, Myanmar (2018)

4.3: Seed Accessibility

Seed accessibility is one of the factors that can determine the level of use of quality seed adoption decisions. It also increases participants' familiarity with and influence their preferences for different types of seed.

Table 4.5 shows the level of participants' accessibility to different types of formal seed sources that can presumable provide quality seed. More than half of the sampled participants for both the crops reported that they had access to the government seed, whereas around 20% reported having access to company seed. As expected, the presence of the local seed producers is not quite widespread, showing that about 5-9% of the participants had access to seed from the local seed

producers. Among people who had access to these seed sources, the nearest places to access seed were located within 5 miles from the participants' villages.

Table 4-5: Access to Seed from the Formal Sector

	Chickpea			Green Gram		
	N	Mean	SD	N	Mean	SD
1= Access to Government Seed	254	0.61	0.49	258	0.62	0.49
Distance to the nearest source to access seed by government (in miles)	152	4.02	3.46	158	4.12	3.80
1= Access to Company Seed	254	0.22	0.41	258	0.26	0.44
Distance to nearest source to access seed by company (miles)	54	4.29	3.09	65	3.96	2.98
1= Access to seed by local seed producers	254	0.05	0.22	258	0.09	0.28
Distance to nearest source to access seed by local seed producers (in miles)	11	3.02	2.51	20	2.60	2.66

Source: Farmer willingness to pay for quality seed survey, Myanmar (2018)

4.4: Preferences for Seed Quality Attributes

Table 4.6 presents participants' preference ratings of different attributes of what quality seed means to them. Farmers were asked to rate each quality trait on a scale of 1=least important to 5=most important. The table shows percentage of participants who rated 1 to 5 for different attributes as well as the average score. The higher average score means farmers considered that attribute to be more important. Since some of these quality attributes (i.e., seed certification, packaging, lab test results) are reflected in the experiment as treatment variables, understanding farmers' preferences for seed attributes can help explain farmers' willingness to pay a premium or not for certain seed products included in the experiments.

For both crops, seed free from pests and diseases have the highest average score, followed by germination rate. However, attributes such as seed health (i.e., seed free from diseases), seed

vigor (i.e., germination rate), seed uniformity (i.e., similar seed size, purity, and seed free from foreign materials) have more or less similar scores with a majority of farmers rating these attributes as important.

Only 45% of farmers for chickpea and 49% for green gram rated seed certification as the most important. Participants seem to care more about the attributes included in seed certification, rather than certification label itself. Similarly, packaging was not rated important relative to other attributes. Both of certification and packaging have the lowest average scores among all the attributes. This pattern is true for both the crops (Table 4.6).

Table 4-6: Participants' Rating of Seed Quality Attributes on a Scale of 1=Least Important to 5=Most Important

	Chickpea							Green Gram						
		Rating							Rating					
Attributes	N	1	2	3	4	5	Average Score	N	1	2	3	4	5	Average Score
		Percentage of Farmers							Percentage of Farmers					
Seed free from Diseases and Pests	254	0	1.18	0.39	27.56	70.87	4.68	256	0.39	4.3	1.95	27.3	66.0	4.54
Germination Rate	254	0	15.75	0	5.12	79.13	4.47	256	0.39	17.2	0	5.08	77.3	4.42
Similar seed size	254	0	1.97	5.51	37.4	55.00	4.45	256	0	4.30	5.86	34.8	55.1	4.41
Purity	253	0	15.81	1.19	11.46	71.54	4.39	254	0	18.1	1.57	10.6	69.7	4.32
Moisture	254	0	19.29	6.30	16.93	57.48	4.13	255	0.78	22.0	9.02	22.8	45.5	3.90
Seed free from foreign material	254	0	7.48	17.72	35.83	38.98	4.06	255	0	7.45	17.3	34.5	40.8	4.08
Certified	253	0.40	32.81	11.86	9.49	45.45	3.67	256	1.17	30.9	10.9	7.81	49.2	3.73
Packaging	254	1.97	52.36	13.39	9.06	23.23	2.99	256	1.17	47.7	15.6	12.9	22.7	3.08

Source: Farmer willingness to pay for quality seed survey, Myanmar (2018)

4.5: Average Willingness to Pay

Table 4.7 shows the average bids of participants for different seed products across three information treatments (T1, T21, T22) included in two rounds of the BDM mechanism experiments. This table also includes the results of the t-test that shows whether the mean bids are statistically significantly different from a base category within a treatment round and for the same product across the treatment rounds. Generally, participants in the study were able to discern quality differences between seed and grain. On average, their bids for certified seed products was significantly higher than their bids for the grain procured from the market. This is true for both the experimental rounds.[11]

Among all the seed products, the seed from the company is the most valued followed by the seed from the local seed producers and the government (i.e., township DOA) for both the crops (See Table 4.7). For chickpea, the market grain was valued least and for green gram, farmer grain was ranked the lowest. However, the price differences between these two grain products are very small for both the crops. The pattern of WTP prices for the three certified seed products across treatment rounds shows a slight decrease in bids from treatment round 1 to treatment round 21 (but not statistically significant). In other words, the additional information on the name and location of the seed source when the certified seed came in the package without the lab test result had no statistically significant effect on farmers' WTP for those seed products compared to the same seed product being sold in bulk with no name or location information (See Table 4.7). The two exceptions were the local seed for chick pea and the company seed for green gram. On average, participants were willing to pay about 250-300 kyats less for the seed from a local seed producer

[11] As a reminder, Round 2 had two information treatments for the three certified seed products – without lab test label (T21) and with lab test label (T22). Bids of all the six certified seed products in Round 2 are compared with the bids of the seed from the market.

for chickpea and the company seed product for green gram if they were branded and packaged, but had no lab test results. This finding is quite counterintuitive, but this is consistent with the descriptive results presented in table 4.6 on farmers' preferences for seed attributes, which indicated that packaging was the least important attribute. It seems that farmers' own ability to physically observe the seed and subjectively assess its quality is very important. This ability is restricted when seeds are packaged, which was reflected in the lower bids for these products in T21. This makes sense, as most of the seeds come in bulk from the informal sector in Myanmar, and farmers have relied on visual inspection of seeds to judge seed quality.

For the grain products, the additional information on the name and location of the seed source had no effect for the seed from the market for both the crops. But for green gram, the additional information on the name and location of the seed procured from a farmer had a statistically significant effect in increasing their WTP for that seed by almost 470 MMK/pyi from T1 to T21 (Table 4.7).

For the three certified seed products, the effect of including a label on the package that provides seed quality lab test results (T22) relative to no such label (T21) was positive and statistically significant for company seed and local seed for both chickpea and green gram. It seems that farmers do not like the seeds with packages because it limits their ability to inspect the seed quality by hand or visually. But the provision of the lab results serves as a quality signaling mechanism and compensates for the restriction posed by seed packaging. For the packaged seed, participants were willing to pay on average about 300 kyats per pyi more for chickpea and 500 kyats per pyi more for green gram, if the package included lab test labeling. For the government seed, this information had no significant effect on farmers' WTP for packaged seed.

Comparing T1 to T22, I find that price differences are not statistically significant for any of the three certified seed products for chickpea. This pattern holds true for green gram for certified seed from the government and the local seed producer. For these seed products, it seems like providing the name and location of the seed source, packaging, and including the lab test results label on the seed package has a small positive but statistically not significant effect relative to selling these seeds in bulk but only with the knowledge on the seed source (and no specificity on name and location). But for the company seed of green gram, the treatment effect of packaging, branding together with providing the lab result was positive and statistically significant. The packaged company seed with a lab result label was the most valued item for green gram with the highest mean WTP of 3750 kyats per pyi (Table 4.7).

Overall, the findings suggest that farmers seem to be deciding their willingness to pay according to the quality differences they are subjectively able to discern rather objective markers of quality signaling such as packaging, branding, and lab results, except for the company seed, which was the most valued seed product. This finding is reinforced by the quality ratings given by participants to different seed products after the two experimental rounds (See Table 4.8, Figure 4.1, and Figure 4.2).

Table 4-7: Average WTP in MMK/pyi [12]

	Chickpea			Green Gram		
Item	T1	T21	T22	T1	T21	T22
Market Grain	1977	1940		2463	2536	
Farmer Grain	2033**	2130**		2408**	2879a**	
Govt Seed	2451**	2295**	2537**	3213**	3275**	3496**
Company Seed	2716**	2472**	2775c**	3334**	3063a**	3748b,c**
Local Seed	2595**	2332a**	2598c**	3272**	3150**	3509c**

'a' means WTP in treatment 21 is statistically significant at 5% level compared to treatment 1.
'b' means WTP in treatment 22 is statistically significant at 5% level compared to treatment 1.
'c' means WTP in treatment 22 is statistically significant at 5% level compared to treatment 21.
'**' mean WTP in each treatment is statistically significant at 5% level compared to market grain in that treatment
Source: Farmer willingness to pay for quality seed survey, Myanmar (2018)

Table 4.8 shows the average rating scores on a 1-5 scale where 1=Worst and 5=Best, given by participants to each seed product included in the information treatment. Farmers were given the opportunity to rate each seed product after they were given the information and they had visually observed the products being mechanism. Higher score means better quality perceived by participants. In general, the company seed products were the most favorite, scoring the highest quality rating score across all the three information treatments, whereas the seed from the market was ranked the worst. All the certified seed items, especially the local producer seeds and the company seeds were scored high across all the information treatments. The quality rating scores for the items with lab result and without lab results were not quite different. This pattern is true for both crops. Table 4.8 also shows the t-test results for quality ratings against market grain as base.

[12] I also ran a non-parametric Wilcoxon signed-rank test, in case assumptions for t-test do not hold. The results of the product comparison to the market grain within rounds are similar to t-test results at Prob> |z|=0.005. I find that the distribution of willingness to pay for round 21 and round 22 is statistically different at 5% level for seed products compared to round 1. Likewise, the distribution of WTP for round 21 and round 22 is also statistically different (See Table A-8 and A-9 for the test results).

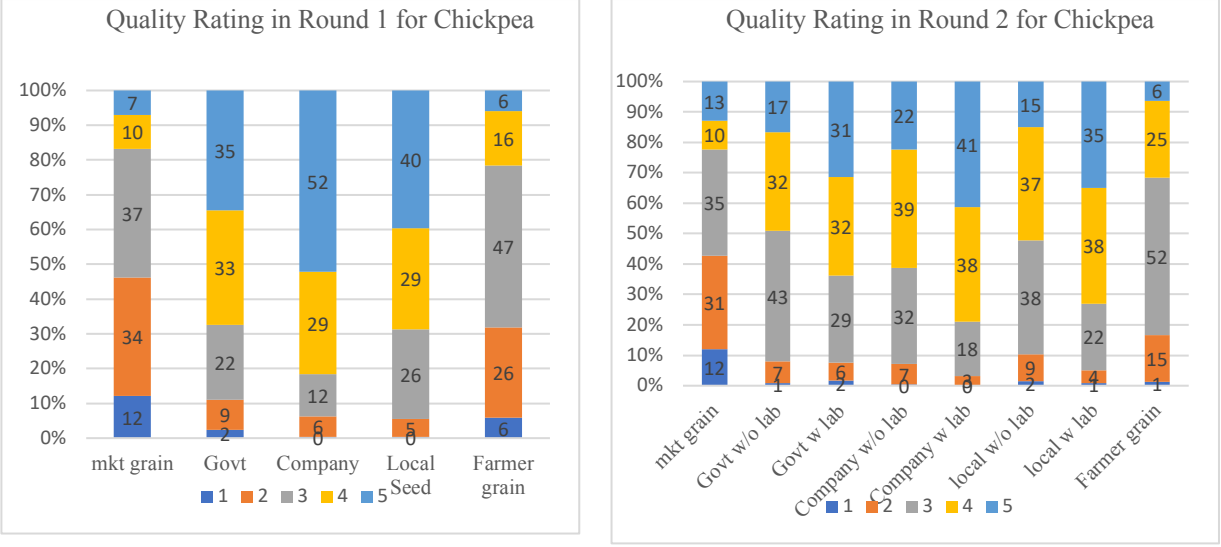
The results show that quality ratings for all products are statistically different from the rating given to market seed in the compared round.

Table 4-8: Average Quality Rating score (1=Worst and 5=Best)

	Chickpea			Green Gram		
Item	T1	T21	T22	T1	T21	T22
Market Grain	2.65	2.8		2.83	2.87	
Farmer Grain	2.9**	3.2a**		2.93	3.33a**	
Govt Seed	3.89**	3.57a**	3.86c**	4.17**	3.65a**	4.17c**
Company Seed	4.27**	3.76a**	4.17c**	4.22**	3.6a**	4.25c**
Local Seed	4.02**	3.55a**	4.02c**	4.08**	3.62a**	3.98c**

'a' means WTP in treatment 21 is statistically significant at 5% level compared to treatment 1.
'b' means WTP in treatment 22 is statistically significant at 5% level compared to treatment 1.
'c' means WTP in treatment 22 is statistically significant at 5% level compared to treatment 21.
'**' mean WTP in each treatment is statistically significant at 5% level compared to market grain in that treatment
Source: Farmer willingness to pay for quality seed survey, Myanmar (2018)

Figure 4-1: % of Farmers Perceived Quality Ratings for Chickpea (1=Worst to 5=Best)



Source: Farmer willingness to pay for quality seed survey, Myanmar (2018)

Figure 4-2: % of Farmers Perceived Quality Ratings for Green Gram (1-Worst to 5-Best)

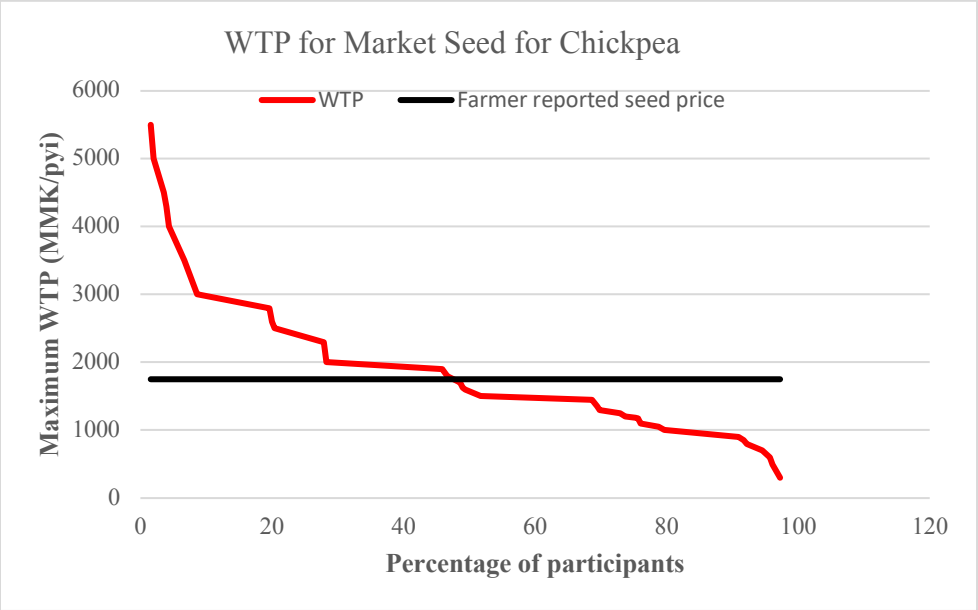
Source: Farmer willingness to pay for quality seed survey, Myanmar (2018)

4.6: Seed Demand Curve

Chickpea

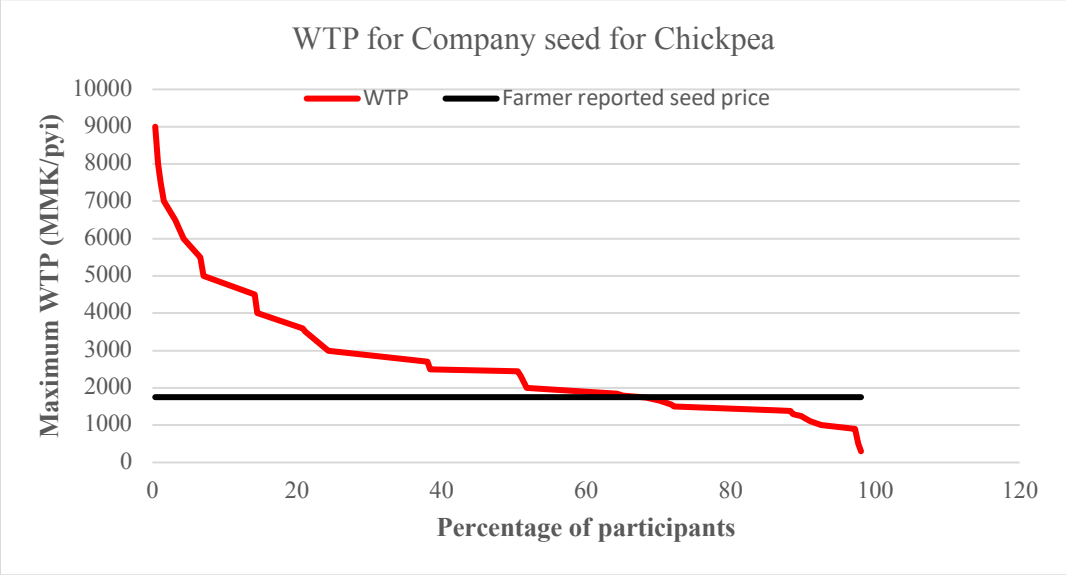
Figure 4.3 and figure 4.4 describe the demand curve for market grain (least preferred seeds) and for company seed (most preferred seeds) for chickpea. It shows the standard downward sloping demand curves with the pattern that the higher the WTP participants bid, the smaller number of participants demanded the seeds. For market seed, a little bit more than 40% of the participants were willing to pay more than farmer reported seed price in the survey compared to about 65% for company seed.

Figure 4-3: Demand Curve for Market Seed for Chickpea



Source: Farmer willingness to pay for quality seed survey, Myanmar (2018)

Figure 4-4: Demand Curve for Company Seed for Chickpea

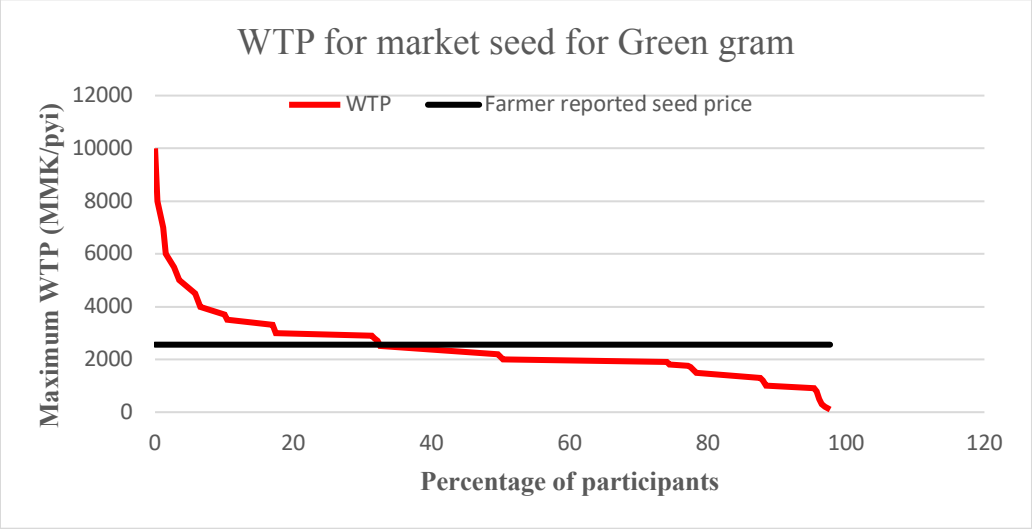


Source: Farmer willingness to pay for quality seed survey, Myanmar (2018)

Green Gram

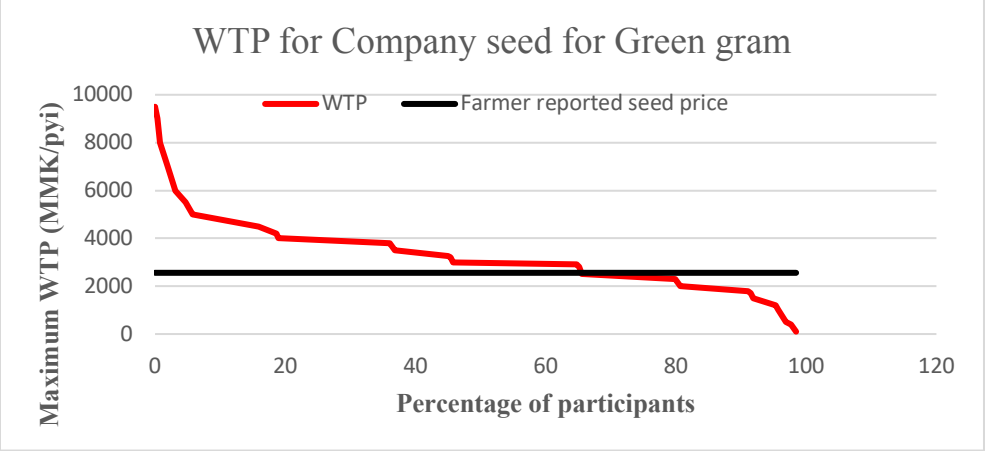
Figures 4.5 and 4.6 represents the demand curves for market seed and company seed respectively. Like chickpea, the higher number of participants were willing to pay more than farmer reported price for company seed compared to market seed. A bit more than 35% of the participants bid more than the farmer reported seed price for market seed whereas about 65% paid more for company seed.

Figure 4-5: Demand Curve for Market Seed for Green Gram



Source: Farmer willingness to pay for quality seed survey, Myanmar (2018)

Figure 4-6: Demand Curve for Company Seed for Green Gram



Source: Farmer willingness to pay for quality seed survey, Myanmar (2018)

4.7: Comparison between WTPs and Cost of Producing Seeds

The main concern with assessing the potential for a market-led seed system for self-pollinated crops like chickpea and green gram is whether farmers' willingness to pay for quality seed would provide enough profit incentive for the private sector to engage in seed production and marketing. Thus, the viability of the seed production depends on whether the WTP prices for quality seed is equal to or greater than the sum of three components: a) cost of production, b) cost of storage and marketing; and c) an acceptable profit margin to entice seed producers to produce quality seed.

Table 4.9 describes the cost of producing green gram certified seeds as well as grain (green gram for crops) in the Central Dry Zone of Myanmar. On the supply side, the production cost of green gram seeds is about 2.3 times higher than the average total cost of grain production. The cost structure indicates that seed production requires more labor and inputs. Generally, seed production requires more fertilizers and agro-chemical products that can nourish plant growth as well as medicines for seed treatment, herbicide, and fungicide. More labor was required as more weeding was done and more chemical inputs were applied.

I do not see much production cost differences in areas other than input and labor between seed production and crop production. The cost for inspection and quality test is minimal; however, the problem is the accessibility to those services, as the government does not have enough capacity to do inspection in many places as well as the lab tests are only located in major cities. Other packaging bags and storage fees were provided by the ISSD, the NGO the surveyed farmers were working with.

Table 4.10 describes the gross margins for producing seeds and grain per acre. The detail explanation of the calculation of the figures is explained in footnotes. It shows that the gross margin for producing grain is 128,329 kyats (about $85). If I consider this as an opportunity cost

for seed producers, it implies that the producers have to earn the minimum revenue of 453,267 kyats (about $302) to cover the cost of producing seed of 324,938 kyats for one acre of seed production.

Table 4-9: Average Cost of Producing Green Gram Seeds Vs. Grains (MMK/Acre)

	Seed		Grain	
	Mean	SD	Mean	SD
Seed	14,708	5,267	15,000	6,335
Other Inputs	104,763	102,733	30,642	19,180
Machine	60,015	24,922	54,744	83,506
Draft Animal	4,962	4,821	2,105	2,993
Labor	140,489	83,913	39,168	42,554
Total	324,938	99,498	141,661	133,501

Source: Cost of Production Survey to Local Seed Farmers (2018)

This break-even point considers only the total cost of seed production, i.e., component 'a' and this opportunity cost of revenues foregone from not producing grain. This translates into the minimum acceptable break-even price of 2350 kyats for one pyi of seed (Table 4-10).

Comparing this break-even price with the WTP estimates from the mechanism experiments, it seems that, about 65% of farmers would be willing to purchase quality seeds by company whereas 40% of farmers would like to purchase quality seeds by local seed producers if it met their perception of quality seed standards (see figure 4.7 and 4.8). This suggests that there is a significant potential market demand for quality seed that can be met by the local seed producers.

However, this break-even price of 2350 kyats/pyi is based on three critical assumptions. First, this does not include the additional cost of storage, transportation, or any marketing costs, i.e., component `b', which producers are likely to bear for doing the seed business. It is unlikely that these costs (esp. storage cost) will be zero. Unlike grain, sale of seeds does not happen immediately after harvest. Producers have to wait until the next cultivation season to sell them as

seed. Given this waiting time, farmers are likely to incur additional costs for storage facilities, packaging, and seed treatment to maintain quality.

Second, this also assumes that producers are willing to accept the same gross margin for seed production as grain, i.e., component 'c' is same for both grain and seed production. However, given the risk, i.e., pest and quality deterioration during the waiting time to sell products, extra labor and management time cost, and higher investment associated with seed production, it is likely that the gross margins a farmer would be expecting from seed production is potentially higher than grain production to cover the additional financial, risk, and time cost Involved in producing seed versus grain.

Table 4-10: Gross Margins for Producing Seeds Vs. Grains per Acre

	grain	seed
Cost per acre	141,661.00	324,938.00
Yield (basket/acre)	9.48 [13]	12.07 [14]
Yield (pyi/acre)	151.68 [15]	193.12 [16]
Cost/pyi	933.95 [17]	1,682.57 [18]
Price/pyi \a	1,780.00	2,347.08 [19] (estimated)
Total revenue per acre	269,990.40 [20]	453,267.40 [21]
Gross margins per acre	128,329.40 [22]	128,329.40 [23]

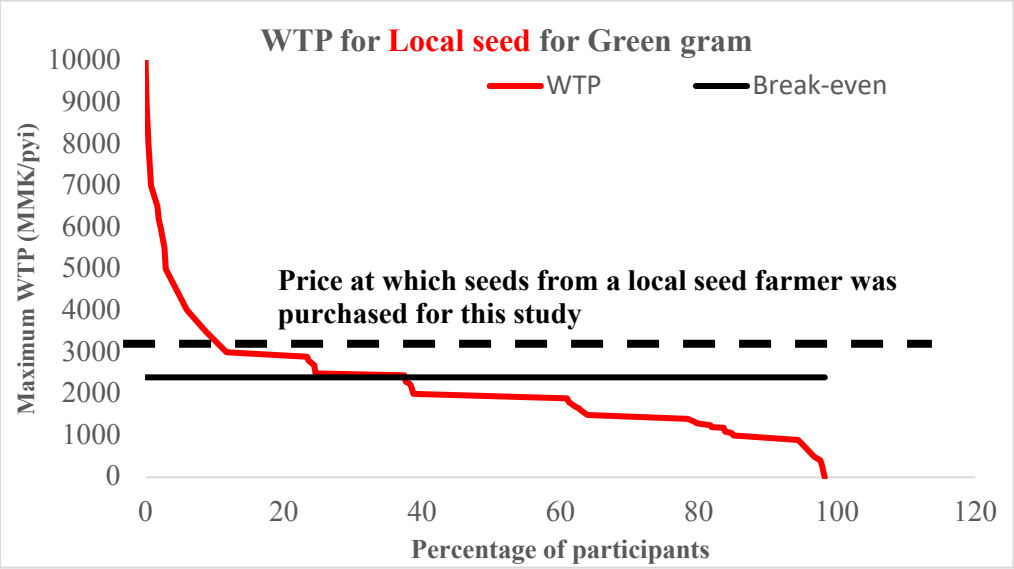
Source: Cost of Production Survey to Local Seed Farmers (2018)
\a Price/Pyi for grain is from another survey (Boughton et al. 2019). Price/Pyi for seed is the estimated break-even price to earn the same level of gross margins as grain.

[13] 9.48 baskets is approximately equal to about 288 kg.
[14] 12 baskets is approximately equal to about 392kg.
[15] one basket is equivalent to 16 pyi. Yield (pyi/acre) is calculated by multiplying yield (basket/acre) with 16 pyi.
[16] Ibid
[17] Price/pyi for seed is calculated by dividing total revenue of the seed by yield (pyi/acre).
[18] Ibid
[19] Price/pyi for seed is calculated by dividing total revenue of the seed by yield (pyi/acre).
[20] Total Revenue for grain is derived by multiplying Price/pyi with Yield (pyi/acre).
[21] Total Revenue for Seed is derived by adding gross margin of grain (opportunity cost) with cost of seed production per acre
[22] Gross margins for grain is calculated by subtracting total revenue from total cost.
[23] ibid

Table 4-10 (cont'd)

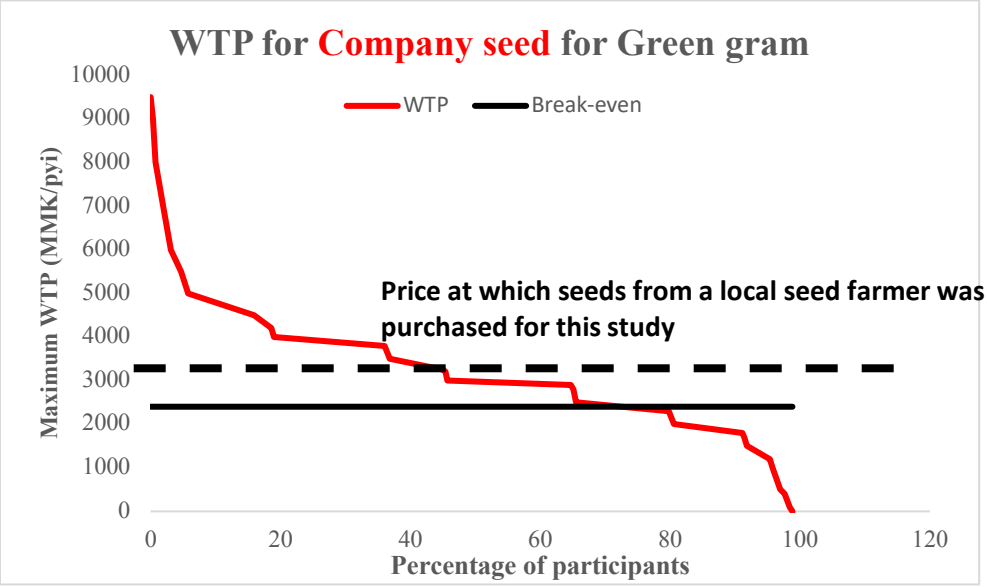
Notes: This calculation is a rough calculation. The cost includes only the major costs listed in table 4.9. This also does not include return to producers' own labor and entrepreneurship.

Figure 4-7: Seed Demand vs Break-Even Point for Local Seed



Source: Farmer willingness to pay for quality seed survey, Myanmar (2018)

Figure 4-8: Seed Demand Vs. Break-even Point for Company Seed



Source: Farmer willingness to pay for quality seed survey, Myanmar (2018)

Third, it assumes that producers will have the technical capacity to produce a similar quality of seeds displayed in the experiment as well as similar quantity (i.e., 12 baskets/acre) observed from the sample of seed producers included in this study. The local seeds I displayed in the experiment were obtained from an experienced local seed producing farmer who had previously worked with the DOA as well as was getting technical support from ISSD. I found during the cost of production survey that other farmers have technical challenges in producing quality seeds. Thus, it is not guaranteed that producers will have enough capacity to successfully produce similar or better-quality seeds and at least 12 baskets per acre assumed in the break-even analysis

Therefore, the viability of local seed production depends on satisfying these three assumptions. Relaxing these assumptions imply increase in the cost of quality seed available to the farmers as consumers, which means that the estimated break-even price of 2,347 kyat/pyi is a lower bound of seed price a local seed producing farmer would be willing to accept. For this study, I obtained the green gram seed from a local seed producer at 3500/pyi. Using this as a most likely price expectation a seed producer would have for getting into seed business, and comparing this with the WTP estimates in Figure 4.8 indicates that about 36% of farmers who participated in the experiment were WTP a price equal to or above 3,500 kyat/pyi. This is a significant drop in the market size from 65% noted above for the break-even price of 2,347 kyat/pyi.

Chapter 5: Regression Results

The estimated effects of information treatments and product attributes through mean comparison presented in Chapter 4 can be biased because they do not control for participant characteristics that can influence a person's WTP. In this Chapter, I present the results of the regression models outlined in Chapter 3 for each crop, which provides estimates of the effect of incremental information on the premium (or discount) farmers are willing to pay for different seed products by controlling for confounding factors, such as unobservable farmer characteristics (i.e., the random effects model) or observable characteristics such as age, gender, education, etc. (i.e., the OLS model).

5.1: Chickpea

Table 5.1 shows the regression results for chickpea from WTP experiments. It describes two models. Model 1 is the random effects model, and model 2 is the normal OLS with household characteristics. For both models, the standard errors are estimated using boot-strapping and clustered at the experimental site level.

First, for both models, the information treatment has no significant effect on WTP in any information treatment round comparisons except for the comparison of T21 and T22 in model 1. This finding suggests that the added information in T21, i.e., packaging, which includes branding, name, and location of the seed source has no statistically significant effect compared to the base value in T1. This result is consistent with the pattern shown in the descriptive analysis. Participants identified packaging as the least important attributes (See Table 4.6). Likewise, the treatment in T22, i.e., packaging and lab results, does not have any significant effect compared to T1.

However, T22 is positively significant compared to T21 under the random effects model. Compared to the packaged products in T21 without the lab result label, packaged products with

lab result label in T22 are valued about 170 kyats per pyi more, holding everything else constant. The seed requirement for chickpea for one acre of cultivated land is around 1 basket (equivalent to 16 pyi) as reported by the participants (See Table 4.2). Thus, for one acre, farmers were willing to pay 3000 MMK (or about US$ 2) more for T22 compared to T21. This amount is financially insignificant.

Secondly, the coefficients for source variables are significant for the two grain products, i.e., farmer grains and market grains, and the company seeds in model 1. Compared to the government seeds, farmers are willing to pay about 180 MMK/pyi less for seeds from the market and other farmers. For company seeds, farmers are willing to pay about 180 MMK more compared to the government seeds. Again, the magnitude is very small even if extrapolating into one acre of cultivation.

The information treatment by product interaction terms are the key variables that measure the incremental effects of additional information for each product relative to the effect of that information treatment on government seeds. As indicated by the non-significant coefficients of the interaction terms across all the columns in Table 5.1, there was no detectable combined effect of information treatment and product attribute on farmers' WTP a higher or lower price relative to the government seeds. This is consistent with generally no effect of information treatment on WTP.

The perceived quality of seeds as reflected in the rating seems to be the most important factor in determining farmers' WTP for different seed products included in the experiments. Under both models, the quality ratings have statistically significant effects on the WTP for all treatment round comparisons. On average a one point increase in quality rating increased farmers' WTP by about 250 kyats/pyi under the random effect model. We can see the bigger effects under the OLS model, but which could be biased without controlling for farmers' random effects. The variable

for previous experience adopting seeds from specific seed sources is not significant in any comparison for both models.

Overall, household characteristics do not seem to be major determinants of farmers' WTP a premium or discount for different seed products except for gender and membership in a farmers' group variables. On average, men have lower WTP in every round comparison. Holding everything constant, relative to women, men were willing to pay about 300 kyats less in T21 and 400 kyats less in T22 compared to T1, and 200 kyats less in T22 compared to T21. Membership in farmers' group is also an important determinant of WTP, indicating that farmers that belong to a group were on average willing to pay 300 kyats premium compared to non-members. Other characteristics such as education, access to irrigation, and distance to paved roads are also statistically significant, but the magnitude of the coefficients is pretty small to be economically meaningful.

Table 5-1: Regression Results for Chickpea

	Model 1			Model 2		
	Dependent Variable=WTP (MMK/Pyi)					
Variables	T1 & T21	T1& T22	T21 & T22	T1 & T21	T1 & T22	T21 & T22
Information Treatment	-85.06	93.46	168.52***	-58.13	102.78	128.41
	[55.10]	[65.57]	[55.69]	[122.99]	[132.72]	[116.63]
Mkt Grain	-182.12**			-150.07		
	[87.59]			[137.51]		
Farmer Grain	-187.35**			-156.13		
	[75.86]			[126.59]		
Company Seed	181.75*	179.20*	147.92**	141.92	128.6	118.44
	[98.76]	[102.80]	[63.11]	[138.96]	[142.02]	[113.54]
Local Seed	112.01	117.64*	46.53	105.12	102.68	78.68
	[74.83]	[69.48]	[45.07]	[138.58]	[140.11]	[113.24]
Information treatment x Mkt Grain	-13.71			-0.31		
	[94.26]			[160.25]		
Information treatment x Farmer Grain	126.11*			57.09		
	[71.45]			[154.32]		
Information treatment x Company Seed	-44.37	-1.77	11.89	-14.81	27.88	21.64
	[84.80]	[90.99]	[84.71]	[175.07]	[192.96]	[174.99]
Information treatment x Local Seed	-84.56	-85.8	-32.36	-41.21	-62.01	-46.25
	[77.39]	[80.76]	[28.77]	[175.69]	[182.41]	[171.54]
Prior Experience with Product	-57.37	99.2	116.81	26.94	178.09	220.6
	[37.27]	[108.04]	[86.09]	[69.68]	[186.49]	[188.85]
Quality Rating [1-Worst to 5-Best]	207.11***	237.71***	287.77***	259.21***	306.58***	372.99***
	[46.96]	[53.20]	[61.98]	[29.80]	[44.07]	[42.50]

Table 5-1 (cont'd)

Variables	Model 1			Model 2		
	Dependent Variable=WTP (MMK/Pyi)					
	T1 & T21	T1& T22	T21 & T22	T1 & T21	T1 & T22	T21 & T22
1=Male				-355.42***	-428.68***	-210.28**
				[79.47]	[115.49]	[103.80]
Age				3.6	1.04	3.68
				[2.66]	[4.04]	[3.91]
Highest Educ Attainment				18.98*	37.31**	28.50**
				[10.34]	[16.44]	[14.05]
HH-size				29.62	30.29	46.13*
				[20.58]	[28.39]	[25.56]
1=HH-head				40.13	51.93	-11.6
				[77.24]	[115.29]	[105.69]
Agric-land Own (Acre)				22.40***	27.74***	15.27*
				[5.43]	[8.47]	[8.23]
Irrigated Area (Acres in Next Season)				-70.81***	-82.23***	-69.05***
				[14.07]	[19.87]	[18.57]

Table 5-1 (cont'd)

	Model 1			Model 2		
	Dependent Variable=WTP (MMK/Pyi)					
Variables	T1 & T21	T1& T22	T21 & T22	T1 & T21	T1 & T22	T21 & T22
Distance to Road (Miles)				-142.99***	-161.97***	-105.32***
				[11.62]	[16.59]	[15.35]
1=Member of Farmers' Group				269.06**	370.33**	315.84*
				[124.47]	[171.27]	[161.93]
Participant Random Effects	Yes	Yes	Yes	No	No	No
Constant	1,651.05***	1,519.85***	1,258.94***	1,382.22***	1,272.51***	698.59**
	[155.23]	[179.50]	[164.55]	[220.57]	[292.81]	[290.48]
R^2 overall	0.0622	0.0331	0.0711	0.13	0.11	0.11
N	2,529	1,519	1,511	2,213	1,329	1,323
Number of Participants [24]	255	255	255	223	223	223

Bootstrapped standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Source: Author's estimation based on WTP Experiments and Participant Survey (2018)

[24] There are some missing values in the household characteristic variables. Thus, the number of observations for model 2 is smaller. To address this issue, the author estimated model 2 by changing each household characteristic variable into categorical variables, and including the missing data as one category. For instance, the gender variable was divided into three categories—one group for male, one group for female, and one group for missing data. For continuous variables such as household size and land ownership, these were converted into three terciles from the lowest values to the highest values and the missing data was included as a fourth group. The regression results (not presented here) show that coefficients of key variables such as information treatment, seed products, quality rating, and the interaction terms were still robust even after accounting for the missing data problem.

5.2: Green Gram

Table 5.2 shows the regression results for green gram based on the same model specifications. Like chickpea, I used the random effects model and the normal OLS to identify factors that determine farmers' WTP for quality seeds. Overall, the findings for green gram are very similar to chickpea.

First, I do not find any statistically significant effects of information treatment on the WTP except for T22 compared to T1. Compared to the seed products sold in bulk, the packaged seeds with lab labels are statistically valued higher. On average, the premium is about 250 MMK per pyi, holding everything constant. This effect is present for both normal OLS and random effect model.

The effects of seed sources on WTP are not present for the certified seed products. Compared to the government seeds, the WTP price premium for the two other certified seed products are not statistically significantly different from zero in general except for the company seed in T22. However, the magnitude is very small to say that the effect of the seed source is important compared to the government seed.

In both models, relative to the WTP price of seed from the government, the value of green gram seeds from the market and other farmers (i.e., grains used as seed) was discounted. The value of this discount was statistically significant. Compared to the government seeds, on average, farmers were willing to pay 400 kyats/pyi less for seeds from the market and about 500 kyats/pyi less for seeds procured from another farmer in random effect model. The similar effect is also present for normal OLS. For one acre of green gram cultivation, it requires about 5 pyi of seeds (See Table 4.2). That means farmers are willing to pay 2000-3000 ($1.3-2) kyats less for grain

seed products for one acre of green gram cultivation. In terms of monetary value, this magnitude is insignificant.

Overall, the interaction terms for treatment and products are not statistically significant except for the company seeds that came with lab test result label. Compared to the packaged company seeds without the lab result, the WTP for the packaged company seeds with the lab results is 400 kyats per pyi higher relative to the price differential between packaged government seeds with and without lab test result. This effect also suggests that at least for the company seeds, even though farmers do not seem to care about packaging alone, they value having lab test result labels on the packaged company seeds. However, this effect seems to be economically insignificant even when extrapolated to one acre of crop cultivation. The effect is not present for other seed products as well.

Like chickpea, the quality rating again seems to be the most important factor in determining the farmers WTP a premium for that seed product. On average, a one unit higher quality rating leads to an increase in WTP of about 300-400 MMK/pyi across round comparisons. In terms of monetary consideration, this magnitude seems big.

For all household characteristics, the gender variable is again statistically significant like chickpea. Compared to a female participant, the WTP for a male participant was about 400 MMK/pyi less in Round 21 and Round 22 compared to Round 1, and about 600 kyats less in Round 22 compared to Round 21. In addition, compared to participants who are not head of the household, household heads tend to bid about MMK 250/pyi less in Round 21 and Round 22 compared to Round 1.

Unlike chickpea, prior experience seems to matter for green gram, which shows the bigger magnitude in OLS, but the effects disappear after controlling for farmers' random effects. Other

household characteristics such as age and land ownership are statistically significant but the magnitude is quite small to be economically meaningful.

Table 5-2: Regression Results for Green Gram

	Model 1			Model 2		
	Dependent Variable=WTP (MMK/Pyi)					
Variables	T1 & T21	T1& T22	T21 & T22	T1 & T21	T1 & T22	T21 & T22
Information Treatment	234.84	285.21*	19.72	189.57	244.75*	13.93
	[177.57]	[170.93]	[111.39]	[148.30]	[142.02]	[138.01]
Mkt Grain	-372.60***			-389.58***		
	[125.71]			[148.39]		
Farmer Grain	-458.94***			-478.23***		
	[119.25]			[145.58]		
Company Seed	112.31	114.28	-193.77*	94.98	130.51	-152.32
	[161.84]	[160.56]	[100.03]	[142.71]	[143.73]	[134.18]
Local Seed	97.49	101.51	-115.22	79.8	130.19	-53.13
	[122.96]	[120.97]	[111.73]	[139.61]	[137.88]	[134.26]
Information treatment x Mkt Grain	-160.52			-127.45		
	[164.01]			[191.64]		
Information treatment x Farmer Grain	110.17			133.72		
	[181.55]			[192.31]		
Information treatment x Company Seed	-310.44	117.32	413.00***	-287.63	152.44	430.20**
	[200.71]	[157.69]	[99.54]	[194.57]	[215.55]	[207.92]
Information treatment x Local Seed	-212.22	-11.15	208.38*	-173.57	28.58	209.07
	[229.97]	[172.43]	[112.70]	[195.31]	[189.49]	[189.69]
Prior Experience with Product	99.29**	132.43	34.16	123.21*	575.71***	521.32***
	[46.33]	[125.79]	[96.02]	[74.58]	[173.14]	[165.81]
Quality Rating [1-Worst to 5-Best]	319.17***	339.84***	390.87***	318.08***	390.03***	400.85***
	[34.79]	[35.84]	[43.51]	[31.87]	[48.70]	[48.07]

Table 5-2 (cont'd)

Variables	Model 1			Model 2		
	Dependent Variable=WTP (MMK/Pyi)					
	T1 & T21	T1& T22	T21 & T22	T1 & T21	T1 & T22	T21 & T22
1=Male				-413.89***	-443.60***	-615.93***
				[85.22]	[128.95]	[136.42]
Age				-9.45***	-14.01***	-11.40**
				[3.09]	[4.94]	[4.70]
Highest Educ Attainment				-27.15**	-17.88	-12.1
				[10.56]	[17.84]	[16.49]
HH-size				-75.24***	-62.27**	-29.27
				[20.29]	[31.34]	[29.76]
1=HH-head				-248.88***	-242.68*	-46.27
				[85.91]	[125.80]	[132.33]
Agric-land Own (Acre)				26.23***	23.29***	23.00***
				[5.82]	[8.78]	[8.22]
Irrigated Area (Acres in Next Season)				22.94	34.83	16.43
				[19.97]	[29.77]	[30.24]

Table 5-2 (cont'd)

	Model 1			Model 2		
	Dependent Variable=WTP (MMK/Pyi)					
Variables	T1 & T21	T1& T22	T21 & T22	T1 & T21	T1 & T22	T21 & T22
Distance to Road (Miles)				-9.54	-25.55	-38.91
				[16.93]	[25.19]	[30.12]
1=Member of Farmers' Group				-46.73	28.86	-142.01
				[133.51]	[226.77]	[224.78]
Participant Random Effects	Yes	Yes	Yes	No	No	No
Constant	1,871.22***	1,780.67***	1,844.18***	2,960.34***	2,760.48***	2,706.01***
	[224.83]	[278.60]	[192.53]	[247.22]	[333.03]	[330.10]
R2 overall	0.0982	0.0638	0.073	0.16	0.12	0.13
N	2,558	1,541	1,534	2,321	1,399	1,393
Number of Participants [25]	258	258	258	234	234	234

Bootstrapped standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Source: Author's estimation based on WTP Experiments and Participant Survey (2018)

[25] There are some missing values in the household characteristic variables. Thus, the number of observations for model 2 is smaller. To address this issue, the author changed each household characteristic variable into categorical variables, including the missing data as one category. For instance, the male variable is divided into three categories—one group for males, one group for females, and one group for missing data. For continuous variables such as household size and land ownership, the author divided them into three terciles from the lowest values to the highest values and included the missing data as the fourth group. The regression result shows that key variables such as information treatment, seed products, quality rating, and the interaction terms are still robust even after accounting for the missing data problem.

5.3: Robustness Check

In order to check the robustness of the regression results in table 5.1 and 5.2, I ran some tests to check whether the results are consistent. First, I run the random effect model by excluding the outliers which are observations that were three standard deviations away from the average WTP since some of the outliers can bias the regression results (Table A-5). Second, it is likely that farmers are using the market seed price as their reference price when expressing their WTP, therefore, I included the farmers' reported market seed price as control in regression (See Table A-6). Finally, the average WTP in round 1 could influence the WTP expressed in next rounds. Thus, I used the average WTP in round 1 as a control variable and ran the regression (See Table A-7).

For both crops, the results for all these robustness checks show very similar results as in tables 5.1 and 5.2 The results indicate three important points as before. First, farmers are willing to pay discount for two grain items sourced from other farmers and the market. However, the magnitude of the discount compared to the government seeds is not monetarily significant. Second, the information treatments do not have any statistically significant effects on farmers' WTP. Finally, perceived quality as reflected in the likert scale rating is the most important factor in determining WTP.

Chapter 6: Conclusion

In light of the global efforts to encourage the use of quality seeds of improved varieties, as well as the recent efforts by the government of Myanmar to reform the seed system, this study was designed to better understand some of the demand and supply side dynamics of two important pulse crops grown in the Kyauk Se and Myin Mu townships in the Central Dry Zone region of Myanmar. On the demand side, I used experimental mechanisms to estimate farmers' willingness to pay for seeds for chick pea and green gram with different quality attributes, and assessed the impact of seed packaging, branding, traceability, and labeling of government lab tests on farmers' WTP a premium for these quality signaling attributes. On the supply side, for green gram, I collected detailed input cost and output data from seed producing farmers in the study area (i.e., seed entrepreneurs) who also produce grain, to estimate the average per unit cost of producing quality seed and grain. I compared these average costs with the estimated WTP price for quality seeds to assess the viability of promoting seed entrepreneurs (i.e., farmers who specialize in producing quality seeds) to meet the local demand for quality seeds closer to the seed source. The results highlight four critical points about the seed system of the focused pulse crops in the study area.

First, the study shows that farmers perceive quality differences between two main categories of seed--certified seeds and recycled seeds (i.e., grain harvested from previous season and used for cultivation), and they are willing to pay a premium for certified seed relative to grain seed. On average, participants expressed a WTP about 35% and 45% price premium for certified seeds of chickpea and green gram, respectively, compared to the WTP price for grain seed in the experiments.

Second, in the absence of a functioning quality assurance system and information asymmetry, farmers rely on assessing the quality of seed through observable characteristics and visual inspection rather than packaging, branding and traceability information, which are considered quality signaling attributes valued by consumers in a perfect market system. This study finds that providing additional information on the identity of the seed source, packaging, and branding had a somewhat negative, but not statistically significant, effect on farmers' WTP a premium for these additional quality signaling attributes. For packaged certified seeds, including the seed quality test result label did increase farmers' WTP a premium relative to packaged seeds without such information label. But the size of this premium was not significantly different from zero when compared with farmers' WTP price for same products sold in bulk without packaging, branding or labeling. This finding suggests the ineffectiveness of the government's quality assurance mechanisms and certification body in Myanmar. Famers trust and value their own ability to assess seed quality more than a quality signaling label included in a packaged seed. Both the OLS and random effects models also show that the only coefficient that was statistically significant across all information treatment comparisons was that of quality rating measured on a likert scale of 1=worst to 5=best.

Lastly, the study looked at the viability and potential role of the local seed production system in the Central Dry Zone of Myanmar. From the experimental mechanisms, we find out that the company seed was valued the highest, followed by the local and the government seeds. However, the t-test results show that WTP premiums between the company seed and the local farmer seeds are not statistically significant in any treatment rounds.

The supply side also confirms the potential role of local seed production. The study shows that the minimum acceptable price for one pyi of green gram to break-even is about 2,400 kyats.

At this point, about 65% of farmers would be willing to purchase the quality seed by the private seed company and about 40% of farmers for the quality seeds by the local seed producer if it met their perception of quality seed standards. However, this break-even point did not consider the additional transportation, storage, and marketing costs which might be likely to incur for seed business, i.e., it is unlikely that the storage cost will be zero, given that producers have to wait until next season for seed sale.

In addition, this break-even point also assumes that producers are willing to accept the same gross margin for seed production as grain. However, it is more reasonable to assume that producers' expected return from seed business is likely to be higher compared to grain, given all the risk, higher investment, extra labor, and management associated with seed production. Finally, the technical capacity to produce a similar quality of seeds displayed in the experiment as well as similar quantity is also not certain. Relaxing to these assumptions could lead to drop in the market share. If we assume the purchased seed price of 3,500 kyats/pyi for this study as the price expected by a local seed producer, the market share drops to 36% of farmers who participated in the experiment.

Finally, I would like to highlight several contributions this study makes to the literature. First, it provides empirical evidence of seed demand for different seed quality products in the context of Myanmar where the seed system is weak and the use of grain as seed is the most important source of planting material for pulse growing farmers. In this respect, this study builds on the recent research by Maredia et al. (2019), Bartle (2019), and Posey (2018) that focus on assessing the demand for seed quality rather than varietal traits.

Second, this study provides empirical evidence on the viability of a decentralized local seed production model recently popularized and promoted by NGOs such as ISSD and other

development partners. Very few studies have done rigorous studies to document cost of production of seed versus grain as done in this study. Third, this study provides new insights on why farmers behave differently in an imperfect market system in the absence of a functioning quality assurance and certification system underlying a perfect market system.

Despite its contribution to the literature and the seed sector development of Myanmar, this study is not free from limitations. Like other demand studies, the study only measures the demand at one point in time; it fails to provide the long-term and recurring demand pattern for quality seed. In addition, even though the study shows the potential role of the local seed producers, we did not address what level of market size is sufficient to encourage a grain producer to become a local seed producer and supply quality seed. It would be an important empirical question to be addressed in the future. Finally, another limitation of the study is the lack of data for chickpea to estimate cost of producing quality seed versus grain. Finally, a limitation of the cost data is that it is based on a small sample of local seed producers observed in one season, which makes it difficult to generalize over space and time.

Despite these limitations, the study provides several policy implications. One of the vital implications of this analysis is the need for programmatic or policy interventions targeted on different cost components with the goal of lowering the price to farmers. This can be done in several ways. First, by providing training to seed producers on seed production, marketing, and storage. Second, financial institutions have to be supportive of the local seed producers. Third, the government has to make sure good quality foundation (or registered) seeds are available to produce certified seed. The local seed farmers in our survey claimed that limited access and availability of foundation seeds they needed to produce certified seed. On the demand side, the extension agents need to train and sensitize farmers on the importance of quality seeds to increase the demand and

the WTP for quality seed. Especially, the seeds by local seed producers have market potential (65% like the company seeds) if farmers can perceive similarly as the quality of company seeds, and therefore, it is important that the government provides training and extension service to farmers to sensitive the quality of seeds produced by the local farmers, in other word, to eliminate the quality signaling conveyed in the information about the source of seeds.

In addition, more research on local seed production is required. Research on understanding different components of cost of producing quality seeds beyond farm level production costs, such as the cost of transportation, marketing, and storage will be important to find leverage points to reduce the cost of quality seeds and to make it more affordable and bring the price below the WTP for seeds for a large number of farmers. Also, more research is needed to find cost-effective ways to ensure seed quality and higher productivity to lower per unit cost of quality seed by local seed producers. Research on producers' willingness to accept a minimum profit margin is also necessary to better understand the viability of the local seed production.

Most importantly, the modernization of government-owned seed laboratories as well as the development of private laboratories will be important in improving the quality assurance system for seeds of pulse crops. Moreover, the government needs to reform the certification process to be more efficient and to be more easily accessible by the private producers. Like in other countries, the government's recognition of the quality declared seeds would be important.

APPENDICES

APPENDIX A: Tables

Table A-1: Tobit Model for Chickpea

	Chickpea		
	Dependent Variable=WTP (MMK/Pyi)		
Variables	T1 & T21	T1& T22	T21 & T22
Information Treatment	-75.37	94.35	149.15**
	[58.79]	[74.58]	[68.95]
Mkt Grain	-171.49*	-185.91*	-157.24**
	[102.24]	[103.25]	[69.40]
Farmer Grain	-173.97*	-181.38*	-70.05
	[93.29]	[93.18]	[63.32]
Company Seed	163.34*	157.80*	123.76**
	[98.18]	[95.62]	[59.67]
Local Seed	113.03	114.41*	48.46
	[69.72]	[62.11]	[50.28]
Information treatment x Mkt Grain	1.09		
	[89.28]		
Information treatment x Farmer Grain	105.74		
	[70.86]		
Information treatment x Company Seed	-30.25	4.24	23.42
	[91.53]	[80.91]	[106.31]
Information treatment x Local Seed	-69.06	-96.58	-38.69
	[71.33]	[84.45]	[49.97]
Prior Experience with Product	27.4	95.19*	84.92
	[59.81]	[55.79]	[65.46]
Quality Rating [1-Worst to 5-Best]	266.62***	291.11***	333.86***
	[35.38]	[63.54]	[71.89]
Participant Random Effect	Yes	Yes	Yes
Constant	1,405.95***	1,304.59***	1,086.53***
	[273.49]	[225.47]	[343.39]
Pseudo R^2	0.0038	0.0039	0.0049
N	2,529	2,029	2,008
Number of Participants	255	255	255

Bootstrapped standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

For Round 1 vs Round 21 Comparison

Left-censored observations at WTP (<=0)= 36

Right-censored observations=6

For Round 1 vs Round 22 Comparison

Left-censored observations at WTP (<=0)= 25

Right-censored observations=5

For Round 21 vs Round 22 Comparison

Table A-1 (cont'd)

Left-censored observations at WTP (<=0)= 27
Right-censored observations=1
Source: Author's estimation based on WTP Experiments and Participant Survey (2018)

Table A-2: Tobit Model for Green Gram

	Green Gram		
	Dependent Variable=WTP (MMK/Pyi)		
Variables	T1 & T21	T1& T22	T21 & T22
Information Treatment	246.25	289.61*	10.43
	[163.97]	[173.79]	[97.99]
Mkt Grain	-375.27***	-387.26***	-520.57***
	[122.66]	[123.24]	[125.57]
Farmer Grain	-459.13***	-473.02***	-361.57***
	[116.13]	[121.60]	[129.63]
Company Seed	113.3	121.64	-191.97*
	[160.62]	[158.41]	[103.42]
Local Seed	101.42	113.24	-104.45
	[115.12]	[112.05]	[114.70]
Information treatment x Mkt Grain	-176.97		
	[141.23]		
Information treatment x Farmer Grain	95.94	127.82	
	[155.80]	[156.91]	
Information treatment x Company Seed	-312.98	-12.94	433.29***
	[200.91]	[166.70]	[106.86]
Information treatment x Local Seed	-213.21		207.09*
	[223.31]		[109.04]
Prior Experience with Product	128	219.43*	167.16*
	[94.10]	[121.05]	[101.06]
Quality Rating [1-Worst to 5-Best]	335.33***	359.45***	398.73***
	[38.53]	[32.99]	[56.96]
Participant Random Effect	Yes	Yes	Yes
Constant	1,799.46***	1,685.65***	1,807.50***
	[226.00]	[214.36]	[275.59]
Pseudo R^2	0.0059	0.0075	
N	2,558	2,056	2,042
Number of Participants	258	258	258

Bootstrapped standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
For Round 1 vs Round 21 Comparison
Left-censored observations at WTP (<=0)= 21
Right-censored observations=5

Table A-2 (cont'd)

For Round 1 vs Round 22 Comparison
Left-censored observations at WTP (<=0)= 17
Right-censored observations=4
For Round 21 vs Round 22 Comparison
Left-censored observations at WTP (<=0)= 8
Right-censored observations=4
Source: Author's estimation based on WTP Experiments and Participant Survey (2018

Table A-3: Household demographics and other characteristics in the Central Dry Zone, Myanmar

Household (HH) characteristic	Mean or %	SD	N
Household size (number of resident members)	4.4	1.6	1,383
HH size in adult equivalents	3.8	1.4	1,383
HH dependency ratio	0.56	0.59	1,354
HH head's age (years)	54	13	1,383
HH head's education (years)	5.8	2.2	1,383
HH head is literate (%)	96	21	1,383
HH head is female (%)	16	36	1,383
HH owns any motorized vehicle (%)	80	40	1,383
HH owns smartphone or other cell phone (%)	87	33	1,383
HH received agricultural credit in last year (%)	74	44	1,383
HH received seed-related ag extension information in last year	57	50	1,383
HH received non-seed-related ag exten. information in last year	62	49	1,383

Notes: 1) Adult equivalent scale from GOM-MPF & WB (2017).
Source: Dry Zone Household Seed Survey (2018) by MSU and Wageningen University

Table A-4: Household landholding in the Central Dry Zone, Myanmar

Household landholding characteristics	Mean or %	Median	N
% of households that own and operate agricultural land (%)	99		1,383
% of households that operate rented- or borrowed-in ag land (%)	6		1,383
Total agricultural land owned and operated by HH (acres)	7.1	5.0	1,365
Total agricultural land rented- or borrowed in & operated (acres)[1]	3.3	2.0	79
Total agricultural land owned, rented/borrowed in & operated (acres)	7.2	5.5	1,383

Notes: 1) figures only computed for those with non-zero values
Source: Dry Zone Household Seed Survey (2018) by MSU and Wageningen University

Table A-5: Chickpea and Green Gram Regression Results after excluding outlier

	Chickpea			Green Gram		
	Dependent Variable=WTP (MMK/Pyi)					
Variables	T1 & T21	T1& T22	T21 & T22	T1 & T21	T1 & T22	T21 & T22
Information Treatment	-11.7	124.92*	123.63**	317.71*	341.80**	12.29
	[61.99]	[71.42]	[59.44]	[178.11]	[162.20]	[97.26]
Mkt Grain	-153.26			-347.09***		
	[99.63]			[97.22]		
Farmer Grain	-171.14**			-390.34***		
	[81.12]			[90.72]		
Company Seed	226.94**	222.97**	114.06*	170.14	186.29	-209.88**
	[106.81]	[110.08]	[60.42]	[141.58]	[140.91]	[97.05]
Local Seed	82.13	88.98	25.34	160.61	179.01*	-129.4
	[71.97]	[72.67]	[23.08]	[100.12]	[96.28]	[111.60]
Information treatment x Mkt Grain	-34.27			-201.53		
	[76.98]			[162.89]		
Information treatment x Farmer Grain	103.95**			-0.49		
	[52.92]			[162.86]		
Information treatment x Company Seed	-117.09	-57.06	43.14	-414.78**	-115.06	303.43***
	[95.52]	[94.77]	[75.81]	[189.84]	[152.62]	[110.12]
Information treatment x Local Seed	-74.53	-40.49	15.27	-306.17	-165.15	164
	[65.19]	[82.36]	[51.31]	[209.33]	[146.99]	[116.64]
Prior Experience with Product	-39.4	125.29	134.2	110.00**	158.12	106.33
	[42.84]	[107.10]	[91.68]	[50.43]	[131.66]	[89.73]
Quality Rating [1-Worst to 5-Best]	187.94***	213.45***	260.92***	291.04***	298.60***	348.44***
	[32.06]	[30.60]	[47.77]	[23.61]	[37.38]	[40.91]

Table A-5 (cont'd)

	Chickpea			Green Gram		
	Dependent Variable=WTP (MMK/Pyi)					
Variables	T1 & T21	T1& T22	T21 & T22	T1 & T21	T1 & T22	T21 & T22
Participant Random Effect	Yes	Yes	Yes	Yes	Yes	Yes
Constant	1,568.39***	1,448.15***	1,272.31***	1,862.40***	1,810.48***	1,956.05***
	[195.62]	[201.30]	[171.93]	[186.08]	[282.17]	[228.65]
R^2 overall	0.077	0.0446	0.0687	0.1026	0.0649	0.0674
N	2,470	1,465	1,467	2,521	1,496	1,496
Number of Participants	253	252	252	258	258	258

Bootstrapped standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Source: Author's estimation based on WTP Experiments and Participant Survey (2018)

Table A-6: Chickpea and Green Gram Regression Results after Including Seed Price as a Reference Price

	Chickpea			Green Gram		
	Dependent Variable=WTP (MMK/Pyi)					
Variables	T1 & T21	T1& T22	T21 & T22	T1 & T21	T1 & T22	T21 & T22
Information Treatment	-74.19	114.63*	182.02***	244.46	233.13	-38.74
	[65.98]	[65.73]	[61.44]	[192.13]	[196.54]	[138.43]
Mkt Grain	-214.75**			-304.75**		
	[106.44]			[131.01]		
Farmer Grain	-164.92*			-404.28***		
	[88.49]			[127.54]		
Company Seed	178.29	166.37	120.49*	153.95	161.75	-241.08**
	[129.24]	[130.09]	[66.65]	[171.47]	[168.72]	[114.66]
Local Seed	134.05	133.16	46.5	148.04	156.44	-82.46
	[90.65]	[84.68]	[60.04]	[135.62]	[138.91]	[111.89]
Information treatment x Mkt Grain	51.37			-191.17		
	[78.46]			[162.25]		
Information treatment x Farmer Grain	81.25			83.23		
	[84.41]			[191.58]		
Information treatment x Company Seed	-70.59	-19.92	17.61	-410.95*	132.32	527.37***
	[109.96]	[117.41]	[95.00]	[211.14]	[183.52]	[129.68]
Information treatment x Local Seed	-104.36	-93.13	-17.05	-239.58	2.36	248.40*
	[90.88]	[92.38]	[35.60]	[250.81]	[170.45]	[140.23]
Prior Experience with Product	-53.16	81.76	81.4	61.68	154.54	122
	[39.30]	[129.21]	[105.85]	[51.21]	[161.10]	[142.66]
Quality Rating [1-Worst to 5-Best]	196.23***	241.58***	258.57***	311.08***	319.01***	376.74***
	[51.15]	[61.57]	[59.52]	[38.63]	[41.37]	[39.33]
Farmer Reported Seed Price	0.06	0.04	0.07	0.16	0.11	0.09
	[0.10]	[0.14]	[0.12]	[0.14]	[0.16]	[0.16]

Table A-6 (cont'd)

	Chickpea			Green Gram		
	Dependent Variable=WTP (MMK/Pyi)					
Variables	T1 & T21	T1& T22	T21 & T22	T1 & T21	T1 & T22	T21 & T22
Participant Random Effect	Yes	Yes	Yes	Yes	Yes	Yes
Constant	1,467.02***	1,324.34***	1,139.22***	1,428.25***	1,501.29***	1,591.56***
	[220.74]	[275.46]	[230.96]	[314.19]	[472.45]	[479.11]
R^2 overall	0.0735	0.0424	0.0791	0.1035	0.0603	0.071
N	2,202	1,325	1,318	2,340	1,410	1,403
Number of Participants	222	222		236	236	236

Bootstrapped standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Source: Author's estimation based on WTP Experiments and Participant Survey (2018)

Table A-7: Chickpea and Green Gram Regression Results for Round 21 and Round 22 after Including Round 1 Average Price

	Chickpea	Green Gram
	Dependent Variable=WTP (MMK/Pyi)	
Variables	T21 & T22	T21& T22
Information Treatment	167.43***	25.5
	[57.53]	[112.61]
Company Seed	147.42**	-193.66*
	[64.83]	[100.79]
Local Seed	46.66	-114.81
	[46.50]	[113.63]
Information treatment x Company Seed	13.2	414.44***
	[85.13]	[100.21]
Information treatment x Local Seed	-30.73	206.66*
	[28.41]	[113.90]
Prior Experience with Product	130.19	48.62
	[87.04]	[104.95]
Quality Rating [1-Worst to 5-Best]	287.14***	379.07***
	[63.57]	[45.38]
Round 1 Average Price	0.71***	0.77***
	[0.08]	[0.10]
Participant Random Effect	Yes	Yes
Constant	-405.23	-370.92
	[257.26]	[382.68]
R^2 overall	0.5055	0.3635
N	1,511	1,534
Number of Participants	255	258

Bootstrapped standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Source: Author's estimation based on WTP Experiments and Participant Survey (2018)

Table A-8: Results of Wilcoxon Signed-rank Test for Chickpea

Item	T1 vs T21	T1 vs T22	T21 vs T22
	Prob>|z|	Prob>|z|	Prob>|z|
Market Grain	0.6999		
Farmer Grain	0.00		
Govt Seed	0.09	0.03	0.00
Company Seed	0.00	0.19	0.00
Local Seed	0.00	0.04	0.00

Source: Farmer willingness to pay for quality seed survey, Myanmar (2018)

Table A-9: Results of Wilcoxon Signed-rank Test for Green Gram

Item	T1 vs T21	T1 vs T22	T21 vs T22
	Prob>|z|	Prob>|z|	Prob>|z|
Market Grain	0.48		
Farmer Grain	0.00		
Govt Seed	0.64	0.01	0.00
Company Seed	0.00	0.00	0.00
Local Seed	0.08	0.08	0.00

Source: Farmer willingness to pay for quality seed survey, Myanmar (2018)

APPENDIX B: Bidding Experiment Study Script

Script for Green gram/Chickpea Seed– BDM Experiment and Farmer Survey in Myanmar, August 2018

NOTE: All text in italics are instructions for the person conducting the auction. All text not in italics must be read to the farmer.

There will be total of 17 experiments performed in 12 villages in two townships, Kyauk Se and Myin Mu. For each experiment, about 25 to 35 farmers will participate in a willingness-to-pay (WTP) experiment and a pre and post-auction survey as outlined below. The experiment will follow the BDM method in which participants do not compete against one another but against a randomly selected "market price." The auction will be conducted in a group setting. Participants will provide their real auction bids on a bidding sheet and they will bid one pyi of green gram/chickpea seed. We will use the same variety for all products we are going to display in all the rounds. The varieties will be Yezin 14 for green gram and Yezin 6 for chickpea. Each experiment will have two rounds: round 1 (post-treatment 1) and round 2 (post-treatment 2). For the first round, the products to be displayed will be grain purchased from a farmer, grain purchased in the local market, certified seed from township DOA, certified seed from a company, and certified seeds from the local seed producers/farmers group. In the second round, we will display eight products. All eight products except grain will be packaged with their respective brand name labels. The eight products categories will be grain produced by farmer U Myint Kyaw from Nat Kan village in Magway township, grain purchased in the Yan Pal zay, the local market in Magway township, certified seed from township DOA with the brand name and with or without the lab result, certified seed from the Yangon based Mya Sein Lal Yar company with the brand name and with or without the lab result, certified seed from Shwe Taung Thu, the local seed

producer group with the brand name label and with or without the lab result. Please note that the displayed products will be randomized (in terms of placement) across rounds and across villages. The order of products displayed will be according to the orders on the bidding sheets selected for that village.

The pre-identified participants will be escorted to a common room or area where the experimental auction will be set up. It is required that only one person per household participate. Upon entering, enumerators will hand participants a consent form and a tag with their participant ID #. Participants will be divided into six groups in which each enumerator will be their designated point of contact. Enumerators will help guide participants to spread out accordingly to ensure participants are not too close to one another. After a brief welcome to the experiment, the lead enumerator will walk through the consent form with the participants explaining what will be required of them for the experiment and that they will have the opportunity to leave the experiment at any time. After explaining the consent form, enumerators will answer any questions participants may have. Enumerators will then ask participants (one-on-one basis) the pre-auction survey questions (Module Y and P). After all of the pre-auction questionnaires are completed by the enumerators, the group will move on to the practice round for the BDM auction as one group.

The script below is for the experiment coordinator running the BDM mechanisms.

Step 1: Introduction/consent

The coordinator will introduce him or herself and reiterate the consent script to the farmers and record their verbal consent to participate.

Step 2: Overall description of Experiment

Conductor:

Ok, thank you for being willing to participate. To begin with, let me give you an overall description of what we will be doing. We are interested in getting an idea about how much you would be willing to pay for different seed products of the same variety of green gram/chickpea. All of the seed we have for this experiment is Yezin 14 for green gram (Yezin 6 for chickpeas). We are going to give you 8,000 kyats as participation fee. This money is yours to keep and use as you wish, including the purchase of seed.

But before we start doing actual auctions, we would like to do a practice auction where you are going to bid your maximum willingness to pay for a toothpaste like this (*show the product*). We will give each of you 500 kyats for participating in this practice auction. This money is yours to keep and use as you wish, including the purchase of this tooth paste.

Hold up the toothpaste

Do you have any questions so far?

Step 3: Practice Auction

The conductor will begin explaining the practice experiment.

Ok, so let me explain how you can participate in this experiment. First, we will give you a bid sheet like this where you can bid your maximum willingness to pay for the toothpaste like this. Unlike in most auctions, or in studies you may have participated in the past, in this activity it is possible for everyone to purchase a toothpaste using part or all of your participation fees--500 kyats.

Let me walk through how you will bid and how we will determine who buys and who does not buy a toothpaste.

First, we will hand out a bidding sheet like this one.

Hold up bidding sheet.

On this bidding sheet, you will write down the maximum amount you would be willing to pay for this toothpaste. You can start bidding from 0 kyats to as much as you are willing to pay with an increment of 50 kyats. So for example, you can bid 0 or 55, 120, 250 kyats, 400, 550 kyats, etc--whatever amount you are willing to pay for this toothpaste. Once everyone has written the most they are willing to pay for this toothpaste, we will collect the bidding sheets and move on to determine how many of you will be able to buy a toothpaste.

To determine who buys we will simply draw a random price. This phone has an app that generate a random number (*show the application on the phone to the participants*.). Using the app, we will randomly generate the number that will be used as "random/selling price" for you to make a purchase of the toothpaste. Note that each price has the equal probability of being selected. We will ask one of you randomly to come and participate in this random price selection. This random number that will be the price of this toothpaste for this activity. We will compare this random price with your bid, which will determine whether you buy the toothpaste at that price or not. Let me explain how we will determine that.

The rule for determining who buys or does not buy is the following: If the price you bid is **greater than or equal to** the random price we will draw using the application, then you purchase the toothpaste, ***BUT*** you pay the randomly selected price – **not** what you bid. This means that if you place a bid greater than the randomly selected price, you pay a lower price for the toothpaste than you bid (unless the random price is the same as your bid).

On the other hand, if the price you bid is **less than** this random price, then you do not purchase the toothpaste, but at the end of this activity we will give you 500 kyats. If your bid is

greater than or equal to, we will give you a toothpaste and the remaining amount of your 500 kyats; that is, 500 kyats minus the random price.

For example, if you bid 400 kyats and the random price is 300 kyats, then you would pay 300 kyats for the toothpaste and get the toothpaste, along with the remaining 200 kyats.

If you do not end up buying the toothpaste, you do not spend any of your 500 kyats buying a toothpaste and you will keep your 500 kyats at the end of this whole activity.

So, for example, suppose that "name an enumerator1 in the room" bids 150, I bid 500 and "name an enumerator2 in the room" bids 1,000 kyats. Now suppose that the random price is 300 kyats, in this case, enumerator2 would buy the toothpaste, but would pay 300 kyats, not his/her bid of 1,000 kyats. He/she would get a toothpaste and 500-300=200 kyats. I would also buy the toothpaste and pay 300 kyats so I would also get the toothpaste and have a remaining 200 kyats. Enumerator1 would not buy the toothpaste since his/her bid of 150 kyats is less than random price 300 kyats so he/she would just keep the 500 kyats.

Are there any questions?

Are there any questions so far?

Before we hand out the practice round bidding sheets, let me explain the best strategy in this type of auction. The BEST thing to do is to bid the MAXIMUM amount you are TRULY willing to pay for the product.

If you bid <u>less</u> than what you would be willing to pay might mean that you miss out on buying the toothpaste at a price lower than you would be willing to pay.

Similarly, bidding more than what you would be willing to pay for the toothpaste might mean that you end up having to pay more for the toothpaste than you really want to. For example, if you are willing to pay a maximum of 350 kyats, but you bid 400 kyats and the random price ends up being 400 kyats then you would pay 400 kyats – more than you were willing to!

Overall, your best strategy is to bid the MAXIMUM amount you are TRULY willing to pay.

Ok, let's go ahead and hand out the bidding sheet.

[Hand out bidding sheets]

Ok, go ahead and write down your number from your name tag we handed you earlier – this helps us keep track of everyone's bids- and your bid for the toothpaste. Please do not talk with others until we have collected the bids.

[Collect bidding sheets, making sure that bids and numbers are entered and legible).]

Ok, now let's go ahead and determine the random price.

[Determine random price by calling one of the participant to come and generate a random number using the application on the phone. After generating the number write it down on board. A helper should record this number on one of the bidding sheets so we have this information.]

Ok, so this is the price (*say the random price*) – if you bid more than or equal to this price, you just bought a toothpaste at this price (*say the random price*). If your bid was less than this price (*say the random price*) you will not buy the toothpaste.

Ok, so we will give you the toothpaste (if you bought one) after we do the seed auction.

Step 4: Seed Auction

The auction conductor will begin explaining the seed auction.

ENUMERATOR:

Ok, so hopefully you have a better idea about how this seed auction will operate. It will be very similar to the practice auction you just did, except for a few things:

First, all these products (*pointing out the products displayed on the table*) have one pyi of green gram/chickpea. You will be bidding to purchase a PYI bag of green gram/chickpea (*say green gram for the green gram village or chickpea for chickpea village*) for the variety Yezin 14 for green gram (Yezin 6 for chickpeas). You will be making 5 bids for the first round and 8 bids for the second round – one for each green gram/chickpea seed product. HOWEVER, even though you are bidding for five products and eight products over two rounds, ONLY ONE type in ONE round will actually be bought/sold today. You will not know which seed product is going to be sold until after all two rounds of the auction, so you should bid as if each option in each round might be that product that will be sold/bought by you today as part of this activity.

Second, instead of 500 kyats, we are now giving you 8,000 kyats as your participation fees. Just as before, you can use that money to purchase the binding products or however you would like to do. Any amount you do not use to purchase seed will be able to keep with you following the auction.

Third, Green gram/chickpea (*say green gram for the green gram village or chickpea for chickpea village*) is commonly purchased in basket or pyi. You will bid in term of one pyi here. After you have submitted your bids for two rounds, we will draw a random price for ONE of the products you see in front of you here.

Does everyone understand?

Moving on. Third, this phone has an app that generate a random number (*show the application on the phone to the participants.*) like in the practice round for toothpaste. Like before, using the app, we will randomly generate the number that will be used as "random price" for you

to make a purchase of one pyi of the binding product. Note that each price has the equal probability of being selected. We will ask one of you randomly to come and participate in this random price selection.

Ok, before we hand out the bidding sheets, let me just remind you that your best strategy is to bid the MAXIMUM amount you are willing to pay for each seed quality. Remember, since we are only going to determine a random price for ONE of the seed qualities, you do NOT need to try and spread your 8,000 kyats across the products included in each round– in fact you can bid as much as you would like to for each seed product and not have to worry about spending more than 8,000 kyats.

Any final questions?

As before, please do not talk with others until we have collected the bids.

[Hand out seed bidding sheets.]

Ok, go ahead and write down your ID number (from the card) on your bid sheets. The five seed products you will bid on in this round are:

(*Describe these products in the random order in which they appear in the bidding sheet*)

Grain purchased from a farmer like you that produces chickpea (green gram)

Gain purchased from a local market

Certified seed from township DOA

Certified seed from the Mya Sein Lal Yar company

Certified seeds from the Shwe Thaung Thu, a seed producers/farmers group in Ta Moe village in Magway township

Let me explain a little bit about these products before we proceed. This [*pointing out the grain purchased from a farmer*] is the grain produced by the local farmer like you. This [*pointing*

out the grain purchased in the local market] is the grain that we bought from a local market. This [*pointing out the certified seeds from township DOA*] is the certified seeds that we bought from this township DOA (site phyo yay yone) office. This [*pointing out the certified seeds from the Mya Sein lal Yar company*] is the certified seeds produced by the Mya Sein lal Yar company (site pyo yay myo se company) based in Yangon. Lastly, this [*pointing out the certified seeds produced by the Shwe Taung Thu local seed producers/farmer group in Ta Moe Village*] product was produced by the local seed producers, who are also farmers like you in Ta Moe village in Magway township. These seed producers have a group and their group is called Shwe Taung Thu producing seeds in Magway township. Remember that the variety is the same for all these products.

The order of the products on your bidding sheets will be the same as the product order displayed on this table. Please bid in term of one pyi. Now, we would like to invite you to come forward to inspect the products.

[Invite the participants to come to the front to inspect the seed products.]

[Escort the participants back to their assigned places after their inspection.]

[Ask them to complete the bidding sheets; making sure that bids and numbers are entered in an increment of 50 kyats.]

[Then, ask them to complete the back side for quality rating which measures their perspectives on the quality of the seed products.]

We will now move on to our next round of bidding. The product type we are going to display will be the same as before. But, except grain, all certified seeds will be packaged and labelled. Some packaged seeds would include example of labelling that could include additional information on seed quality based on lab testing. These lab test results will not be on the displayed

sample, but if that seed product is randomly selected, the seed will come with seed quality lab test information.

So, now we will have the eight seed products you will bid on this round - grain produced by farmer U Myint Kyaw from Nat Kan village in Magway township, grain purchased in the local market Yan Pal zay, certified seed from township DOA with or without a lab result, certified seed from the Yangon based Mya Sein lal Yar company with or with a lab result and certified seed from the Shwe Taung Thu local seed farmer group with or without a lab result. We will now briefly explain the differences in each product before we hand you your next bidding sheet to fill out. These two products [pointing out grain purchased by farmer U Myint Kyaw in Nat Kan village and grain purchased in the Yan Pal market] are the grain produced by a farmer like you who has surplus grains to sell as seeds to other farmers and grain we purchased in the Yan Pal market in Magway which has traders and exchange centers which sells grains as seeds [*point out each product while explaining this*]. These products [*pointing out all certified products on the table*] are from the same sources as before. One of the differences from what we showed before is that now these products are labeled and packaged. The labels on these seed packages include information such as the name of the organization/company or farmer group that produced the seed, its location, the name of the variety, where/when the seed was produced, etc. Some of these products [*pointing out all certified products on the table*] have additional information about the seed quality in terms of germination rate, purity and moisture content, etc. For example, one of these products [*pointing out the certified seeds from township DOA with a lab result*] will include a lab test result like this and one [*pointing out the certified seeds from township DOA without a lab result*.] does not come with this additional information. You will see the note saying "certification from the laboratory is included" on the packages of the products with the lab result. So now, we have eight products-

grain produced by farmer U Myint Kyaw from Nat Kan village in Magway township, grain purchased in the Yan Pal, the local market in Magway, certified seed from township DOA with or without a lab result, certified seed from the Yangon based Mya Sein Lal Yar company with or without a lab result, certified seed from the Shwe Taung Thu, local seed producer group with or without a lab test result.

Are we clear? Does anyone have any question?

Please take note, however, that on every package of the certified products with a lab result, there is a table printed on the packages, describing the purity, germination rate, moisture level, and life span. The information inside the table (*show the table on the package*) are blank for now. But, when you bid the product, bid as if the table has actual information that guarantees the quality- for example, the germination rate of XX%, for example. If this product is selected for the actual purchase, you will get this seed with the information about the lab test result from us.

Are there any questions?

[*Hand out seed bidding sheet #2*.]

Ok, go ahead and write down your ID number (from the card) on your bid sheets again. Please place bids for all eight seed products again.

Now we would like to invite all of you to come forward and inspect the products.

[*Invite the participants to come to the front to inspect the seed products*.]

[*Escort the participants back to their assigned places after their inspection*.]

[*Collect bidding sheets, making sure that bids and numbers are entered in an increment of 50 kyats.]*

[*Then, ask them to complete the other side table with the quality rating which measures their perspectives on the quality of the seed products.*]

Random Price determination

Now comes the exciting part of determining who will end up buying one pyi of seed today. Before we draw the random price, we need to decide for which Round and which product the seed will be sold/purchased today. We will first randomly select one of the two rounds. To determine this, we have these 2 folded papers with numbers 1 and 2 written on it. We will ask one of you to pick one of these two papers, and whichever number is picked will be the Round number for drawing the price.

[*Determine which Round is binding by asking one of the farmers to pick on the folded sheet of paper. Show everyone which Round was selected*]

Now that we have determined the Round number [*selected number*], the next thing is to select one of the products. To minimize the seed transportation challenges, before coming to this village, we had randomly selected this green gram/ chickpea seed product [*reveal the seed product as previously determined*]. So now that we know the Round and the product let's go ahead and determine the random price.

[*Determine random price as outlined above while writing it down on board.]*

This is the "market price" of this seed product for Round X. If your bid for this product in Round X was more than or equal to this price, you just bought a pyi bag of this quality seed along with the remaining money. If your bid was less than this price you will not buy seed but will receive the 8,000 kyats.

Ok, so we will call you up one or two at a time to give you the seed/toothpaste if you bought them and however much we owe you towards your participation fee for the toothpaste and the seed.

[*Hand out the post-auction survey.]*

However, before we do that, some of the enumerators will be asking you questions to complete a post-auction survey. After you have completed your survey, please stop by here to settle your seed/toothpaste purchase and however many Myanmar kyats we owe you.

Thank you all for your time to participate in this study.

Thank you!

APPENDIX C: Bidding Experiment Survey Questionnaire

Willingness to Pay for Green gram/Chickpea Quality Seed -- Farmer Survey in Myanmar, August 2018

Z. Farmer Identification

Z0. First read the Consent Statement. Proceed if the farmer consents. Farmer consented:					☐ 1-Yes ☐ 2-No
Z2. Are you the main (or one of the main) decision maker in your household for green gram/chickpea cultivation and practices?					☐ 1-Yes ☐ 2-No
Z3. Farmer Name		Z4. Gender	☐ 1-Male ☐ 2-Female	Z5. Age	
Z6. Telephone #		Z7. Type of phone	1-Basic phone 2-Smart phone 3-Landline		

P. Prior use of seed from different sources and quality rating

P1. Source	P2. Have you ever used green gram/chickpea seed from <source> before? 1=Yes 2=No	P3. How would you rank the quality of green gram/chickpea seed from each of the following sources? Assign a number from 1=best to 6=worst; do not repeat a number 96=no opinion on that seed source/system
a. Own Saved Seed		
b. Grain from other farmer		
c. Grain purchased in the market		
d. Public/Government (DOA) (Certified)		
e. Certified Seed Produced by seed producers		
f. Certified seed from private company		

A. INFORMATION ABOUT THE FARMER AND HIS/HER FAMILY

A1. Can you read and write? [1] Yes] No	A2. Your highest level of education al attainment ?	A3. Total number of household members	A4. Your relationship with the head of the HH [1] Self <A6 [2] Spouse <A6 [3] Other	A5. How many acres of agricultura l land does your household own?	A6. How many years have you grown green gram/chickpe a?	A7. What will be the total area you plan to cultivate with green gram/chickpe a in this upcoming season? (acres)	A8. How many acres of your green gram/chickpe a crop will be irrigated in upcoming season?

A9. Are you a member of farmer group/ organizatio n? [1] Yes [2] No	A10. Have you ever received any training on… [1] Yes [2] No		A11. Distance to the nearest market center in minutes (using a motorbike) ?	A12. Distance to the nearest main road in miles?	A13. Do you sell green gram/ chickpea as seed? [1] Yes [2] No	A14. What is the current price per pyi of green gram/chickpea seed if you were to buy/sell it? (Price/pyi)
	A10a. Green gram/ chickpea farming?	A10b. Seed quality?				

B. ASSETS OWNED AND CHARACTERISTICS OF THE HOMESTEAD

B1. How many of the following assets/household items does your HH own?	B2. How many of these animals does your HH own?	B3. What type of stove is used most often for cooking food in the household? 1=Open fire, open stove, rice-husk stove, or traditional closed stove 2=A1 improved stove, other improved stove, stove using electricity, gas, kerosene/diesel, or biofuel, or other	B4. What is the major construction material of the floor? 1=Earth/sand/palm/bamboo or other 2=Wood planks, parquet or polished wood, tongue-and-groove wood, cement	B5. What is the major construction material of the external (outer) walls of your house? 1=Thatch/large leaves/palm/dhani, or tarpaulin 2=Bamboo, or rudimentary wood 2 3=Unbaked brick and mud, finished wood, or other 4=Baked brick and cement, or pucca cement

a. Smart phones	b. TV	c. 4W tractor	d. 2W tractor	e. Solar panel	f. Motorcycle	g. Bicycles	h. cupboard or food storage cabinet	a. Cow/ Cattle/ oxen	b. Goats/sheep	c. Chickens (only count adult animals)	d. Pigs			

C. INFORMATION ABOUT FARMING PRACTICES

C1. Have you ever used or purchased certified seed of green gram/chickpea? [1] Yes <C3 [2] No	C2. If no, why not? (see codes	C3. Normally, what type of seed do you use for cultivation for green gram/ chickpea? [1] grain [2] certified seed [3] both	C4. On average, what percentage of your green gram/chickpea seeds are certified seed? (0-100)	C5. Distance to the nearest source to access green gram/chickpea seed by township DOA? [miles] 999-No known access to such seed	C6.Distance to the nearest source to access certified green gram/chickpea seed by private companies? [miles] 999-No known access to such seed	C7. Distance to the nearest source for purchasing certified green gram/chickpea seed by local seed farmers/producers? [miles] 999-No known access to such seed

Code for not using certified seed:
1=Expensive/cannot afford /cash constraint
2=Don't trust the quality
3=Not available
4=Not available on time
5=Don't know this type of seed
6=Not adaptable to local conditions
99=other (specify)
_____

C8. When it comes to adopting new technology, inputs or farming practices, which of the following best describes your behavior (read the list): 1 - I am one of the first ones to adopt NEW technologies 2 – I usually wait until a few farmers I know have used those inputs/technologies/practices, and then based on their experiences I make the decision 3 – I usually wait until most farmers in this village are already using those inputs/technologies/practices, and I am 100% sure that those technologies work 4 – I rarely change my farming practices as I am not comfortable doing new things

C9. How many acres of land do you cultivate green gram/chickpea in a normal year?	C10. Total quantity produced in a normal year (baskets)	C11. What percent (%) of your green gram/chickpea harvest do you sell in a normal year? (0-100)	C12. In a normal year, what percent (%) of your green gram/chickpea total production cost is devoted to seeds? (0-100)

D. Varietal level information

D1. In the last season, how many green gram/chickpea varieties did you plant?	D2 Variety ID	D3. Name of the chickpea/ green gram variety planted in last season this crop was grown	D4. What was the source of the seed you planted last season? [1] own harvest [2] neighbor/other farmer [3] Market/trader [4] Agrodealer [5] DOA [6] Private company [7] Seed producer [99] Other (specify)	D5. What type of seed it was? [1] grain [2] certified	D6. In your opinion is this variety an improved or a traditional variety? [1] Improved [2] traditional	D7. Quantity of seed per acre of this variety was planted last season? [pyi]	D8. How satisfied were you with the quality of seed you used last season? 1=very dissatisfied 2=neutral 3=very satisfied	D9. Year you first planted this variety on your farm YYYY
	V1							
	V2							
	V3							
	V4							

E. Importance of seed quality

	Please rate on a scale of 1 to 5 (Mark the appropriate column)				
	1	2	3	4	5
	Very Important	Somewhat important	Neutral	Not important	Not at all important
E1. In your green gram/chickpea seed selection decision, how important are each of the following characteristics.					
a. Similar Seed size					
b. Seed Free from Diseases and Pests					
d. Packaging (bag type or size)					
e. Seed free from dirt, stones, foreign material					
f. Certified – Inspected by government					
g. Purity					
Germination Rate					

F. Green gram/chickpea SEED DEMAND

F0. Type ID	F1. Seed type	F2. Based on your bids for the last round of auctions, how many pyi of green gram/chickpea seed of your preferred variety would you be willing to purchase if the following seed types were available at that price? Write 0 for none	F3. From all the seeds you saw today, which seed did you LIKE the MOST? 1=LIKE MOST 0=NOT LIKED MOST	F4. What is the MAIN reason for not bidding higher than what you bid today for this seed you liked most? 1=I was comparing the market price 2=No money/cannot afford 3=I was bidding what I heard other farmers were bidding 99=Other (specify)
a	Grain from farmer			
b	Grain purchased in the market			
c	Certified seed purchased from township DOA			
d	Certified seed produced by the local seed producer group			
e	Certified seed produced by private company			

APPENDIX D: Bidding and Quality Rating Sheets

Practice Auction Bidding Sheet

Farmer ID	

Your Bid	Enter the most you are willing to pay MMK

Random price: _____

Village Name		
Village ID		
Participant purchased the item	Yes ☐	No ☐
Total Cash Owed	1000 – Random price = kyats	1000 kyats

Farmer ID _____ Village Name _____ Township_____
Set A

Chickpea/Green Gram -- Round 1

Set A	Enter Your Maximum Willingness to Pay
Grain purchased in the local market	MMK _____
Certified Seed from the township DOA	MMK _____
Certified Seed from Mya Sein Lal Yar company	MMK _____
Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village	MMK _____
Grain purchased from a farmer	MMK _____

----------X----------X----------

The following is to be filled by enumerators.

Type of seed selected for auction.	Grain purchased in the local market Certified Seed from the township DOA Certified Seed from Mya Sein Lal Yar company Certified Seed from Shwe Taung Thu local seed producers/farmer group Grain purchased from a farmer	
Random Price		
Participant purchased the item	☐ Yes (if bid is greater or equal to random price)	No ☐
Total Cash Owed	8,000 – Random price = _____ Kyats (plus bag of seed)	8,000 kyats

Farmer ID _____ Village Name _____ Township_____

Chickpea/Green Gram--Round 1: Quality Rating

Type of Products	Rating [Please circle your answer.]
Grain purchased in the local market	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Certified Seed from the township DOA	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Certified Seed from Mya Sein Lal Yar company	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Grain purchased from a farmer	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad

/

Farmer ID _____Village Name _____ Township_____
Set A

Chickpea/Green Gram -- Round 2

Set A	Enter Your Maximum Willingness to Pay
Packaged Certified Seed from Mya Sein Lal Yar company without a lab report	MMK _____
Grain purchased from farmer U Myint Kyaw, a farmer in Nat Kan village in Magway township	MMK _____
Packaged Certified Seed from Mya Sein Lal Yar company with a lab report	MMK _____
Packaged Certified Seed from the township DOA without a lab report	MMK _____
Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village with a lab report	MMK _____
Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village without a lab report	MMK _____
Packaged Certified Seed from the township DOA with a lab report	MMK _____
Grain purchased in Yan Pal zay, the local market in Magway township	MMK _____

----------X----------X----------

The following is to be filled by enumerators.

Type of seed selected for auction	Packaged Certified Seed from Mya Sein Lal Yar company without a lab report Grain purchased from farmer U Myint Kyaw, a farmer in Nat Kan village in Magway township Packaged Certified Seed from Mya Sein Lal Yar company with a lab report Packaged Certified Seed from the township DOA without a lab report Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village with a lab report Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village without a lab report Packaged Certified Seed from the township DOA with a lab report Grain purchased in Yan Pal zay, the local market in Magway township	
Random Price		
Participant purchased the item	☐ Yes (if bid is greater or equal to random price)	☐ No

Total Cash Owed	8,000 – Random price= _____ Kyats (plus bag of seed)	8,000 kyats

Farmer ID _____Village Name _____ Township_____

Chickpea/Green Gram--Round 2: Quality Rating

Type of Products	Rating [Please circle your answer.]
Packaged Certified Seed from Mya Sein Lal Yar company without a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Grain purchased from farmer U Myint Kyaw, a farmer in Nat Kan village in Magway township	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from Mya Sein Lal Yar company with a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from the township DOA without a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village with a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village without a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from the township DOA with a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad

Grain purchased in Yan Pal zay, the local market in Magway township	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad

Farmer ID _____ Village Name _____ Township_____
Set B

Chickpea/Green Gram -- Round 1

Set B	Enter Your Maximum Willingness to Pay
Certified Seed from the township DOA	MMK _____
Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village	MMK _____
Grain purchased in the local market	MMK _____
Grain purchased from a farmer	MMK _____
Certified Seed from Mya Sein Lal Yar company	MMK _____

----------X----------X----------

The following is to be filled by enumerators.

Type of seed selected for auction	Certified Seed from the township DOA Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village	
	Grain purchased in the local market Grain purchased from a farmer Certified Seed from Mya Sein Lal Yar company	
Random Price		
Participant purchased the item	☐ Yes (if bid is greater or equal to random price)	No ☐
Total Cash Owed	8,000 – Random price = _____ Kyats (plus bag of seed)	8,000 kyats

Farmer ID _____ Village Name _____ Township_____

Chickpea/Green Gram--Round 1: Quality Rating

Type of Products	Rating [Please circle your answer.]
Certified Seed from the township DOA	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Grain purchased in the local market	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Grain purchased from a farmer	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Certified Seed from Mya Sein Lal Yar company	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad

/

Farmer ID _____Village Name _____ Township_____
Set B

Chickpea/Green Gram -- Round 2

Set B	Enter Your Maximum Willingness to Pay
Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village without a lab report	MMK _____
Grain purchased from farmer U Myint Kyaw, a farmer in Nat Kan village in Magway township	MMK _____
Packaged Certified Seed from Mya Sein Lal Yar company with a lab report	MMK _____
Packaged Certified Seed from the township DOA without a lab report	MMK _____
Grain purchased in Yan Pal zay, the local market in Magway township	MMK _____
Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village with a lab report	MMK _____
Packaged Certified Seed from the township DOA with a lab report	MMK _____
Packaged Certified Seed from Mya Sein Lal Yar company without a lab report	MMK _____

----------X----------X----------

The following is to be filled by enumerators.

Type of seed selected for auction	Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village without a lab report Grain purchased from farmer U Myint Kyaw, a farmer in Nat Kan village in Magway township Packaged Certified Seed from Mya Sein Lal Yar company with a lab report Packaged Certified Seed from the township DOA without a lab report Grain purchased in Yan Pal zay, the local market in Magway township Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village with a lab report Packaged Certified Seed from the township DOA with a lab report Packaged Certified Seed from Mya Sein Lal Yar company without a lab report	
Random Price		
Participant purchased the item	☐ Yes (if bid is greater or equal to random price)	☐ No
Total Cash Owed	8,000 – Random price= _____ Kyats (plus bag of seed)	8,000 kyats

Farmer ID _____Village Name _____ Township_____

Chickpea/Green Gram--Round 2: Quality Rating

Type of Products	Rating [Please circle your answer.]
Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village without a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Grain purchased from farmer U Myint Kyaw, a farmer in Nat Kan village in Magway township	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from Mya Sein Lal Yar company with a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from the township DOA without a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Grain purchased in Yan Pal zay, the local market in Magway township	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village with a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from the township DOA with a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from Mya Sein Lal Yar company without a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad

Farmer ID _____ Village Name _____ Township_____
Set C

Chickpea/Green Gram -- Round 1

Set C	Enter Your Maximum Willingness to Pay
Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village	MMK _____
Certified Seed from Mya Sein Lal Yar company	MMK _____
Grain purchased in the local market	MMK _____
Certified Seed from the township DOA	MMK _____
Grain purchased from a farmer	MMK _____

----------X----------X----------

The following is to be filled by enumerators.

Type of seed selected for auction	Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village Certified Seed from Mya Sein Lal Yar company Grain purchased in the local market Certified Seed from the township DOA Grain purchased from a farmer	
Random Price		
Participant purchased the item	☐ Yes (if bid is greater or equal to random price)	No ☐
Total Cash Owed	8,000 – Random price = _____ Kyats (plus bag of seed)	8,000 kyats

Farmer ID _____ Village Name _____ Township_____

Chickpea/Green Gram--Round 1: Quality Rating

Type of Products	Rating [Please circle your answer.]
Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Certified Seed from Mya Sein Lal Yar company	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Grain purchased in the local market	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Certified Seed from the township DOA	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Grain purchased from a farmer	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad

Farmer ID _____ Village Name _____ Township_____
Set C

Chickpea/Green Gram -- Round 2

Set C	Enter Your Maximum Willingness to Pay
Packaged Certified Seed from the township DOA without a lab report	MMK _____
Grain purchased from farmer U Myint Kyaw, a farmer in Nat Kan village in Magway township	MMK _____
Grain purchased in Yan Pal zay, the local market in Magway township	MMK _____
Packaged Certified Seed from Mya Sein Lal Yar company with a lab report	MMK _____
Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village without a lab report	MMK _____
Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village with a lab report	MMK _____
Packaged Certified Seed from Mya Sein Lal Yar company without a lab report	MMK _____
Packaged Certified Seed from the township DOA with a lab report	MMK _____

----------X----------X----------

The following is to be filled by enumerators.

Type of seed selected for auction	Packaged Certified Seed from the township DOA without a lab report Grain purchased from farmer U Myint Kyaw, a farmer in Nat Kan village in Magway township Grain purchased in Yan Pal zay, the local market in Magway township Packaged Certified Seed from Mya Sein Lal Yar company with a lab report Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village without a lab report Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village with a lab report Packaged Certified Seed from Mya Sein Lal Yar company without a lab report Packaged Certified Seed from the township DOA with a lab report	
Random Price		
Participant purchased the item	☐ Yes (if bid is greater or equal to random price)	☐ No
Total Cash Owed	8,000 – Random price= _____ Kyats (plus bag of seed)	8,000 kyats

Farmer ID _____ Village Name _____Township_____

Chickpea/Green Gram--Round 2: Quality Rating

Type of Products	Rating [Please circle your answer.]
Packaged Certified Seed from the township DOA without a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Grain purchased from farmer U Myint Kyaw, a farmer in Nat Kan village in Magway township	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Grain purchased in Yan Pal zay, the local market in Magway township	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from Mya Sein Lal Yar company with a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village without a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village with a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from Mya Sein Lal Yar company without a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from the township DOA with a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad

Farmer ID _____ Village Name _____ Township_____
Set D

Chickpea/Green Gram -- Round 1

Set D	Enter Your Maximum Willingness to Pay
Certified Seed from Mya Sein Lal Yar company	MMK _____
Grain purchased in the local market	MMK _____
Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village	MMK _____
Grain purchased from a farmer	MMK _____
Certified Seed from the township DOA	MMK _____

----------X----------X----------

The following is to be filled by enumerators.

Type of seed selected for auction	Certified Seed from Mya Sein Lal Yar company Grain purchased in the local market Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village Grain purchased from a farmer Certified Seed from the township DOA	
Random Price		
Participant purchased the item	☐ Yes (if bid is greater or equal to random price)	No ☐
Total Cash Owed	8,000 – Random price = _____ Kyats (plus bag of seed)	8,000 kyats

Farmer ID _____ Village Name _____ Township_____

Chickpea/Green Gram--Round 1: Quality Rating

Type of Products	Rating [Please circle your answer.]
Certified Seed from Mya Sein Lal Yar company	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Grain purchased in the local market	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Certified Seed from Shwe Taung Thu local seed producers/ farmer group in Ta Moe Village	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Grain purchased from a farmer	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Certified Seed from the township DOA	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad

Farmer ID _____ Village Name _____
Township_____ set D

Chickpea/Green Gram -- Round 2

Set D	Enter Your Maximum Willingness to Pay
Grain purchased in Yan Pal zay, the local market in Magway township	MMK _____
Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village without a lab report	MMK _____
Packaged Certified Seed from the township DOA without a lab report	MMK _____
Packaged Certified Seed from Mya Sein Lal Yar company with a lab report	MMK _____
Packaged Certified Seed from the township DOA with a lab report	MMK _____
Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village with a lab report	MMK _____
Packaged Certified Seed from Mya Sein Lal Yar company without a lab report	MMK _____
Grain purchased from farmer U Myint Kyaw, a farmer in Nat Kan village in Magway township	MMK _____

----------X----------X----------

The following is to be filled by enumerators.

Type of seed selected for auction	Grain purchased in Yan Pal zay, the local market in Magway township Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village without a lab report Packaged Certified Seed from the township DOA without a lab report Packaged Certified Seed from Mya Sein Lal Yar company with a lab report Packaged Certified Seed from the township DOA with a lab report Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village with a lab report Packaged Certified Seed from Mya Sein Lal Yar company without a lab report Grain purchased from farmer U Myint Kyaw, a farmer in Nat Kan village in Magway township	
Random Price		
Participant purchased the item	☐ Yes (if bid is greater or equal to random price)	☐ No
Total Cash Owed	8,000 – Random price= _____ Kyats (plus bag of seed)	8,000 kyats

Farmer ID _____Village Name _____ Township_____

Chickpea/Green Gram--Round 2: Quality Rating

Type of Products	Rating [Please circle your answer.]
Grain purchased in Yan Pal zay, the local market in Magway township	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village without a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from the township DOA without a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from Mya Sein Lal Yar company with a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from the township DOA with a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from Shwe Taung Thu local seed producers/farmer group in Ta Moe Village with a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Packaged Certified Seed from Mya Sein Lal Yar company without a lab report	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad
Grain purchased from farmer U Myint Kyaw, a farmer in Nat Kan village in Magway township	How would you rate the quality of this product? (1)Best (2)Good (3)Fair (4)Bad (5) Very Bad

APPENDIX E: Cost of Production Survey Questionnaire

Green Gram and Chick Peas Seed Production Survey

Mingalarpar. My name is [..enumerator's name..]. We are conducting a study to estimate the cost of seed production for green gram and chick peas in the Central Dry Zone. This research is generously funded by USAID-Myanmar project.

We will ask you few questions about your farming practices, production costs and marketing techniques related to both of your seed production and crop production. We will finish all questions about green gram today. For chick peas, we will ask a part of questions today and will follow up later after the chick peas is harvested in the winter season.

Including you, we will conduct survey to other green gram and chick peas seed producers in the Central Dry Zone. We will use your information along with those from other seed producers collectively to provide recommendations to policy makers and other stakeholders so that both policy makers and other stakeholders can make evidence-based policy decisions for the development of the Myanmar seed sector. The information you provide will be used only for research purposes. It will be anonymous and confidential.

Your participation is voluntary. Your refusal to participate or to withdraw from the study carries no penalty or loss of any benefits. You are free not to answer any of the questions we will ask. By continuing this interview, you consent to answer my questions which will be part of our research database.

If you have any questions about this study, please contact Myat Thida Win at Michigan State University, phone: 09455577944; email: winmyat@msu.edu.

Enumerator: please sign below to confirm the interviewee's consent.

Enumerator's Sign: _____ Enumerator's Phone Number _____

A. Identification

A100: Enumerator Name _____ A101: Enumerator Code _____ A102: State/Region _____

A103: Township_____ A104: Village_____ A105: Name of Respondent _____

A106: Respondent's Gender _____ 1. Male 2. Female A107: Respondent's Phone Number _____

B. Characteristics of Seed Farmers

B100	B101	B102	B103	B104	B105	B106	B107	B108	B109
What is the name of the seed farmer?	What is your relationship with the seed farmer? Self Spouse Parent Child Sibling 99. Other (specify)	What is the age of the seed producer? [Fill in the completed age]	What is the gender of the seed producer? Male Female	What is the highest educational attainment of the seed producer? Elementary School Middle School High School College Degree Graduate Degree	How many acres of agricultural land does your household own? [Total Acres]	How many acres of them are operating in the last 12 months? [Total Acres]	How many acres of them are used for seed production in the last 12 months? [Total Acres]	Did you produce seed for green gram in the last season? Yes No	Are you going to produce seed for chick peas in the winter season? Yes No

C1. Current Seed Production Overview

No	C100	C101	C102			C103	C104	C105	C106	C107			C108	C109	C110
	Crop	Did you produce seed for [..crop..] in the last 12 months? Yes No → skip to C110	Who did you work with for seed production of [..crop..]? DOA/DAR Seed Company ISSD Self 99. Other (specify) [Please fill in all if the producer works with more than one source.]			What is the type of seed you produce in the last 12 months? Breeder Seed Foundation Seed Registered Seed Certified Seed 99. Other (specify)	How many plots of land did you use for seed production of [..crop..] in the last 12 months? [Total numbers]	What is the average area of each plot in acres? [Acre]	Have you ever received any trainings for seed production of [..crop..]? Yes No→ skip to C110	From whom did you receive the training? DOA/DARNGO Seed Company ISSD/WHH 99. Other (specify) [Answers could be more than one.]			How many days each training takes?	When was the earliest year you received the training? [YYYY]	Did you cultivate [..crop..] for crop production in the last 12 months? Yes No→ Next crop
1	Rice														
2	Sesame														
3	Groundnut														
4	Black gram														
5	Pigeon pea														

6	Vegetables														
7	Green gram														
8	Chick peas														
99	Other (specify)														

C2. Past Experiences

C200: Have you ever had any experiences producing seeds for any crop before you worked with ISSD/WHH? 1. Yes 2. No _____

If 2, skip to D.

No	C201	C202	C203	C204			C205	C206	C207
	Crop	Have you ever produced seed for the following [..crop..] before? Yes No→ next crop	When did you start producing seed for [..crop..]? [YYYY]	Who did you work with for seed production of [..crop..] before? DOA/DAR Seed Company Self NGO 99. Other (specify) [Please fill in all if the producer worked with more than one source.]			What was the type of seed you produce? Breeder Seed Registered Seed Foundation Seed Certified Seed 99. Other (specify)	Have you ever grown [..crop..] for grain production? Yes No→skip to next crop	When did you start cultivate [..crop..] for grain cultivation? [YYYY]
1	Rice								
2	Sesame								
3	Groundnut								
4	Black gram								
5	Pigeon pea								
6	Vegetables								

7	Green gram								
8	Chick peas								
99	Other (specify)								

Instructions

Enumerator: Next questions will be related to green gram seed production. Remember that if the farmer has more than one plots growing green gram for seed production, choose the LARGEST plot to interview the next sections. We are only interested in the seed production of green gram produced in the LAST SEASON.

Seed Production for Green Gram

D1. Input Cost

The following is for the seed production of green gram. Ask the following questions for the largest plot only.

D100		D101	D102			D103		
Input	Code	Did you use [..input..] for the largest plot in the last season for green gram seed production?	what was the total quantity of [..input..] used for the entire season?			What was the price per unit of [..input..]?		
		1 Yes 2 No→NEXT INPUT	Amount	Bag Viss Bottle Can Package Gallon Bucket Cart Pyi Basket 99 Other (specify)	Per… Acre Total	Price	Kyats 2. Lakh Kyats	Unit Bag 2 Viss 3 Bottle 4 Can 5 Package 6 Gallon 7 Bucket 8 Cart 9 Pyi 10 Basket 99 Other (speciy)
Fertilizer	1							
Herbicide	2							
Pesticide	3							
Fungicide	4							
Manure	5							

Other (specify)	99							

D1. Continued

D104			D105			D106	D107	D108
What was the amount of the seed you used for cultivation of seed in the last season?			What was the price per unit of the seed?			What was the type of seed you used for seed production of green gram?	From whom did you purchase the seed?	From where did you buy the seed?
Amount	Pyi Basket 99. Other (specify)	Per.. Acre Total	Price	Unit Kyat Lakh Kyat	Per.. Pyi Basket 99. Other (specify)	Foundation Seed Registered Seed Foundation Seed Certified Seed 99 Other (specify)	1. DOA/DAR 2. NGO 3. ISSD/WHH 99. Other (specify)	1. In this village 2. In this village tract 3. In this township 4. In this state/region 5.Naypyitaw 99. Other (specify)

D2. Machinery Cost

The following is for seed production of green gram. Ask the following questions for the largest plot only.

D201		D202	D203	D204	D205		D206			
Activities		Did you use machinery for [..activity..] in the last season?	Type of machinery used	What was the ownership of [..machine..]?	How many units did you use the [..machine..] for [..activity..]		How much did you spend for the use of machinery (including fuel, rental, food, etc.) for [..activity..] for the entire season? [if D204 is own, ask for other costs such as fuel, food, etc]			
		1 Yes 2 No →NEXT TASK	1 One wheel tractor 2 Two wheel tractor 3 Four wheel tractor 4 Combine harvester 5 Thresher 6 Trawlerjee 7 Engine/generator 99 Other (Specify)	1 Rented 2 Own 3 Borrowed 99 Other (Specify)	Amount	Unit 1 Acre 2 Basket 3 Hour 4. Half-day Day 99. Other (specify)	Amount	1 Kyat 2 Lakh Kyat	Unit 1 Acre 2 Basket 3 Hour 4. Half-day 5 Day 6. Total	Total Unit if unit is total, this question this is not related. 98 NA
	CODE									

									99. other (specify)	
Land preparation	1									
Turning soil between planted furrows	2									
Intercultivation	3									
Harvesting	4									
Threshing /winnowing	5									
Hauling inputs or harvested crops	6									
Weeding	7									
Others (specify)	99									

D3. Draft Animal Cost

The following is for seed production of green gram. Ask the following questions for the largest plot only.

D301		D302	D303	D304		D305			
Activities		Were any draft animals used for [..activity..] for the largest plot for green gram seed production in the last season?	What was the ownership of these animals?	How many units did you use the [..machine..] for [..activity..]		How much did you spend for the use of draft animals (including operator cost, rental, food, etc.) for [..activity..]?			
	CODE	1 Yes 2 No → NEXT ITEM	1 Rented 2 Own 3 Borrowed 99 Other (Specify)	Amount	Unit 1 Acre 2 Basket 3 Pair 4 Half day 5 Day 99 Other (specify)	AMOUNT	1 Kyat 2 Lakh Kyat	Unit 1 Acre 2 Basket 3 Pair 4 Half day 5 Day 6 Total 99 Other (specify)	Total Units if unit is total, this question is not related. 98 NA
Land preparation	1								
Direct Seedling	2								

Turning soil between planted furrows	3								
Intercultivation	4								
Harvesting	5								
Threshing/winnowing	6								
Weeding	7								
Hauling inputs or harvested crops	8								
Others (specify)	99								

D4. Labor Cost

The following is for seed production of green gram. Ask the following questions for the largest plot only.

D401		D402	D403	D404	D405	D406	D407		D408			D409	
Activity	CODE	Did you use labor for [..activity..] in the last season?	Type of Labor	Total No. Persons	Is it Paid by:	What is the daily rate you paid?	No of days/half-days		PIECE RATE			Other payments (meals, transport etc.)	
									AMOUNT	Unit	Total units	Kyats	Unit
		1.Yes 2 No → Next activity	1.Family → D409 2.Hired 3.Hired Group 4.Exchange→D409		1 Daily 2 Piece Rate →D408	Kyat/ Day	Number	Unit Days Half days After this, skip to D409		1 Acre 2 Basket 3 Sack 4 Bundle 5 Bag 6 Total 99 Other (specify)	98 NA if unit is total this question is irrelevant		1 Per person 2 Total 99 Other (specify)
Seedling preparation	1												

Land preparation (excluding labor in draft animal and mechanizatio n)	2												
Cultivation (broadcasting /transplanting)	3												
Weeding by hand	4												
Fertilizer application	5												
Herbicide application	6												
Fungicide application	7												
Pesticide/inse cticide application	8												
Harvesting	9												
Threshing	10												
Winnowing	11												
Transport harvest w/animal (exclude labor in draft animal and	12												

mechanizatio n)													
Drying	13												
Cleaning seed	14												
Other(specify)	99												

E. Outputs

The following is for seed production of green gram. Ask the following questions for the largest plot only.

No	E101	E102	E103
	When was the planting date of green gram for the largest plot?	When did you harvest in the last season?	What is the variety that you produced?
	MM/YY	MM/YY if harvested more than one write down in separate lines.	Name of Variety
1			
2			
3			
4			
5			

E. Output: Continued

E104	E105	E106	E107	E108	E109	E110	E111	E112	E113
How many baskets in total did you harvest in the recent season from the largest plot?	How many of your total harvest was lost due to pest/disease?	How many baskets have you sold in total (as both grain and seed) so far?	Of the total sale, how many baskets were sold as seed?	Whom did you sell it as seed?	Where does your buyers from?	What was the average unit price you received per basket from seed sale?	Why did you sell part or all of your harvest as seed right after the harvest?	Of the total sale, how many baskets were sold as grain?	Why did you sell part or all of your harvest as grain right after the harvest?
Baskets	Baskets	Baskets	Baskets 98 NA	Trader Other Farmers Company Broker Exchange center Other (specify) 98 NA	From this village Nearby village From this village tract From this township From this state/region 99. Other (specify) 98 NA	98 NA	1. Financial Concern 2. Storage difficulties 3. Quality is not good enough to store for long 99. Other (specify) 98 NA	98 NA	1.Quality is not good enough to sell as seeds 2. Seeds were rejected by lab 3. Financial concern 4. Storage difficulties 99. Other (specify)

									98 NA

E114	E115	E116	E117	E118
Out of total harvest, how many baskets are still left to sell?	Of total amount left, how much percentage do you expect to sell as seed?	What is the unit price you expect to receive per basket if you sell as seed?	When do you expect to sell the remainders as seed?	How many baskets will your keep for home consumption or to use as seed for grain production?
Baskets	% 98 NA	Kyats/basket 98 NA	MM/YYYY 98 NA	Baskets 98 NA

F. Storage, Branding, and Packaging

Ask the following for sale of seeds for green gram only.

F101	F102	F103			F104	F105	F106	F107
How did you/will sell the seed you produced?	Where did you store the seed that is still left to sell?	What is the average total cost (including medicines, bag, rent of storage area, labor, etc) for storing the seed until you finish selling all of them?			During the season, did you receive any inspection from DOA/DAR?	How many times on average did you receive the inspection for the entire season?	How much does it cost each time you receive an inspection?	Do you have to send your sample for laboratory check?
With package, brand label, and lab result Just bag the seed without any brand 99. Other (specify) 98 NA	1. At home 2. In a separate storage room 3. In a community storage room you shared with other producers in your village 99. Other (specify) 98 NA	Cost 98 NA	Unit Basket Pyi Package Total 99. Other (specify)	Total Unit If unit is total, this is irrelevant. 98 NA	Yes No→F107		Kyats	Yes No→F110 98 NA

F108			F109	F110	F111		
How much does it cost for laboratory check?			Have you ever experienced that your seed sample was rejected by lab for failing to meet the standard?	Did you also do any marketing for sale of your seed?	What is the channel you used most for seed sale?		
Cost	Unit 1. Basket 2. Pyi 3. Package 4. Total 99. Other (specify)	Total Unit if unit is total this question is not relevant 98 NA	1. Yes 2. No 98 NA	1. Yes 2. No→ Next module 98 NA	1. Through fb 2. Through other farmers 3. Through township DOA 99. Other (specify) Answers can be more than one.		

G. Weather Situations

Please record major observations happened on the largest plot during the recent season.

Rainfall (mark as many as possible):

G100	G101
Rain came too early Too much rain Too little rain It rained during the harvest season	

Pest and disease incidence

G100	G101
Unusually high incidence of insect problem Unusually high incidence of disease problem Unusually high incidence of weed problem	

Yield

G100	G101
Due to the weather season, the yield was lower than normal. Because of good practices, the yield was higher than normal.	

Crop Production of Green Gram

H. Crop Production Overview

H101	H102	H103	H104	H105
Did you grow green gram for crop production in the last season? Yes No→End of Survey	How many plots of land did you grow green gram for crop production in the last season?	On average, what is the average area of one plot?	What is the area of the largest plot?	In all of your plots, did you grow the same variety as that of seed production? 1 Yes 2 No

Instructions
Enumerator: Next questions will be related to green gram crop production only. Remember that if the farmer has more than one plots growing green gram for crop production, prioritize the plot which was grown the same variety as that of the seed production. Otherwise, choose the LARGEST PLOT. We are only interested in the seed production and grain production of green gram produced in the LAST SEASON.

I1. Input Cost

The following is for crop production of green gram. Ask the following questions for the largest plot/plot you choose only.

I100		I101	I102			I103		
Input	Code	Did you use [..input..] in the largest plot for crop production in the last season?	what was the total quantity of [..input..] used for the entire season?			What was the price per unit of [..input..]?		
		1 Yes No→NEXT INPUT	Amount	Bag 2 Viss Bottle Can Package Gallon Bucket Cart Pyi Basket 99 Other (specify)	Per… Acre Total	Price	Kyats 2 Lakh Kyats	Unit 1 Bag 2 Viss 3 Bottle 4 Can 5 Package 6 Gallon 7 Bucket 8 Cart 9 Pyi 10 Basket 99 Other (specify)
Fertilizer	1							
Herbicide	2							
Pesticide	3							
Fungicide	4							
Manure	5							
Other (specify)	99							
	__							

I1. Continued

The following is for seed production of green gram. Ask the following questions for the largest plot/plot you choose only.

I104			I105			I106	I107	I108
How much of the seed did you use in the last season for green gram cultivation?			What was the price per unit of the seed?			What was the type of seed you used for crop production of green gram?	From whom did you purchase the seed?	From where did you buy the seed?
Amount	Pyi Basket 99. Other (specify)	Per.. Acre Total	Price	Kyats Lakh Kyats	Pyi Basket 99. Other (specify)	Foundation Seed Registered Seed Foundation Seed Certified Seed Grain 99 Other (specify)	1. DOA/DAR 2. NGO 3. ISSD 99. Other (specify)	1. In this village 2. In this village tract 3. In this township 4. In this state/region 5.Naypyitaw 99. Other (specify)

I2. Machinery Cost

The following is for crop production of green gram. Ask the following questions for the largest plot/plot you choose only.

I201		I202	I203	I204	I205			
Activities		Did you use machinery for [..activity..] in the last season?	Type of machinery used	What was the ownership of [..machine..]?	How much did you spend for the use of machinery (including operator, fuel, rental, food, etc.) for [..activity..]?			
	CODE	1 Yes 2 No →NEXT TASK	1 One wheel tractor 2 Two wheel tractor 3 Four wheel tractor 4 Combine harvester 5 Thresher 6 Trawlerjee 7 Engine/generator 99 Other (Specify)	1 Rented 2 Own 3 Borrowed 99 Other (Specify)	Amount	1 Kyat 2 Lakh Kyat	Unit 1 Acre 2 Basket 3 hour 4. half-day 5 day 6. total 99. other (specify)	Total Unit if unit is total, this question this is not related. 98 NA
Land preparation	1							
Turning soil between planted furrows	2							
Intercultivation	3							
Harvesting	4							
Threshing/winnowing	5							
Hauling inputs or harvested crops	6							
Weeding	7							
Other (specify)	99							

I3. Draft Animal Cost

The following is for crop production of green gram. Ask the following questions for the largest plot/plot you choose only.

I301		I302	I303	I304			
Activities		Were any draft animals used for this activity in the last season?	What was the ownership of these animals?	How much did you spend for the use of draft animals (including operator, rental, food, etc.) for [..activity..]?			
	CODE	1 Yes 2 No →NEXT ITEM	1 Rented 2 Own 3 Borrowed 99 Other (Specify)	AMOUNT	1 Kyat 2 Lakh Kyat	Unit 1 Acre 2 Basket 3 pair 4 Half day 5 Day 6 Total 99 Other	Total Units if unit is total, this question is not related. 98 NA
Land preparation	1						
Direct Seedling	2						
Turning soil between planted furrows	3						
Intercultivation	4						
Harvesting	5						
Threshing/winnowing	6						
Weeding	7						
Hauling inputs or harvested crops	8						
Others (specify)	99						

I4. Labor Cost

The following is for crop production of green gram. Ask the following questions for the largest plot/plot you choose only.

I401		I402	I403	I404	I405	I406	I407		I408			I409	
Activity	CODE	Did you use labor for [..activity..] in the last season?	Type of Labor	Total No. Persons	Is it Paid by:	What is the daily rate you paid?	No of days/half-days		PIECE RATE			Other payments (meals, transport etc.)	
									AMOUNT	Unit	Total units	Kyats	Unit
		1.Yes 2 No → Next activity	1.Family→ I409 2.Hired 3.Hired Group 4.Exchange →I409		1 Daily 2 Piece Rate →I408	Kyat/ Day	Number	Unit 1=Day2 =Half days After this, skip to I409		1 Acre 2 Basket 3 Sack 4 Bundle 5 Bag 6 Total 99 Other (specify)	98 NA if unit is total this question is irrelevant		1 Person 2 Total 99 Other (specify)
Seedling preparation	1												
Land preparation (excluding labor in draft	2												

animal and mechanization)													
Cultivation (broadcasting/ transplanting)	3												
Weeding by hand	4												
Fertilizer application	5												
Herbicide application	6												
Fungicide application	7												
Pesticide/insecticide application	8												
Harvesting	9												
Threshing	10												
Winnowing	11												
Transport harvest w/animal (exclude labor in draft animal and mechanization)	12												
Drying	13												
Cleaning seed	14												

Other(specify)	99												

J. Output

The following is for crop production of green gram. Ask the following questions for the largest plot/plot you choose only.

No	J101	J102	J103
	When was the planting date of green gram for crop production?	When did you harvest green gram for crop production?	What is the variety that you produced?
	MM/YY	MM/YY if harvested more than one write down in separate lines	Name of Variety
1			
2			
3			
4			
5			

J. Continued

J104	J105	J106	J107	J108	J109	J110	J111	J112
How many baskets in total did you harvest in the recent season?	How many baskets of your total harvest was lost due to pest/disease?	How many baskets will you keep for home consumption and use as seed on your farm?	Of the total harvest, how many baskets have you sold in total so far?	Whom did you sell it as grain?	Where does your buyers from?	What was the average unit price you received per basket for grain sale?	Out of total harvest, how many baskets are still left to sell?	What is the unit price you expect to receive per baskets when you sell the remainder?
				Trader Other farmers Company Broker Exchange center Other (specify) 98 NA	From this village Nearby village From this village tract From this township From this state/region 99. Other (specify) 98 NA	Kyats/basket 98 NA	Baskets	Kyats/basket 98 NA

K. Weather Situations

Please record major observations happened on the plot you chose during the seed growing season.

Rainfall (mark as many as possible):

K100	K101
Rain came too early Too much rain Too little rain It rained during the harvest season	

Pest and disease incidence

K100	K101
Unusually high incidence of insect problem Unusually high incidence of disease problem Unusually high incidence of weed problem	

K100	K101
Due to the weather season, the yield was lower than normal. Due to good practices, the yield was higher than normal.	

L. Challenges

L101				L102			
What are the major challenges you face as a green gram seed producer?				What are the major challenges you face as a green gram crop farmer?			
Accessibility of quality seed Weather situation Logistic problem to storage seed for long Technical problem to storage seed for long Financial difficulty to storage seed for long Limited demand for your output 99. Other (specify) Answers can be more than one.				1. Accessibility of quality seed 2. Weather situation 3. labor shortage 4. Input cost too high 5. Output Market Instability 6. Limited access to credit 99. Other (specify) Answers can be more than one.			

APPENDIX F: Conversion Rates

1 Pyi of Chickpea= 2.04 kg

1 Pyi of Green Gram= 1.96 kg

1 Basket=16 Pyi

1 U.S. dollar = 1500 Myanmar Kyats

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