Analysis of the Operational Constraints of the Rice Value Chain in Ayeyarwaddy Region, Myanmar

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ABSTRACT

The rice industry is the most important agriculture subsector in Myanmar. However, far lower profits are gained from producing rice in Myanmar compared with those gained in other rice-producing ASEAN countries. This paper analyzes the operational constraints experienced by the different actors in the rice value chain in Myanmar. Both primary and secondary data on the rice value chain in Ayeyarwaddy Region, the main rice-growing area in Myanmar, were collected. The actors in the region suffer from constraints in material input, production, financial, distributional, and institutional. This study examines the actors' profitability, together with their sociodemographic and operational characteristics, to provide proper policy guidelines to address constraints. The analysis revealed that the value chain in the study area is structurally inefficient, characterized by a large number of actors who face numerous constraints. Diverse policy recommendations are then put forward to improve the rice value chain in the Ayeyarwaddy Region. Stakeholders need to implement projects that would increase the quantity and quality of rice produced, ranging from input quality control to more efficient extension services. Credit and sufficient working capital should also be provided to make infrastructure investments possible at each stage of the value chain in order to improve production and profitability.

INTRODUCTION

Agriculture plays a major role in Myanmar as the sector ensures food security and provides employment and income to a growing population. In 2014–2015, 22.1 percent of the national GDP came from agriculture (MOAI 2015a). The rice industry is the most important agriculture subsector in the country, accounting for about half of the cultivated land. In 2016, paddy production in Myanmar ranked seventh among all the paddy-producing countries in the world (Statista 2017). Official data also cite that paddy has the highest percentage share (46%) among all the crops grown in Myanmar (MOALI 2016). In addition, most of the household income of the country's population comes from rice farming and related activities. In 2013–2014, the net profit from producing monsoon paddy averaged USD 114 per hectare (ha). However, these farm profits, in general, are not sufficient to raise households' per capita income above the regional rural poverty line (Zorya 2016). Furthermore, Zorya (2016) reported that Burmese farmers gain lower profits from rice farming as compared with those gained by rice farmers in other ASEAN countries. This indicates that the potential of the agriculture sector in Myanmar to reduce poverty is yet to be realized.

Value chain development is an approach for reducing rural poverty, which has been adopted by various governments and NGOs (World Bank 2014). In this paper, we analyze the rice value chain in Ayeyarwaddy Region, Myanmar. The issues in this region are complex and multifaceted. For one, information is lacking with regard to the coordination and interaction between the actors operating in the same stage (horizontal cooperation) and in the different stages of the supply chain (vertical cooperation) due to the fragmented linkages and relationships among the actors. Thus, this study examines these constraints in order to identify the main bottlenecks.

This paper follows the framework of Trienekens (2011) and starts from the network structure of the rice value chain. In particular, this study aims to:

1. examine the sociodemographic characteristics of the actors in the chain and to analyze, via a profitability analysis, the value addition in the different stages; and
2. identify the major constraints limiting the operations of each actor.

The operational constraints are related to the profitability of each actor via a regression analysis, in order to identify the most significant specific constraints. This way, we can identify the appropriate options to take to improve the value chain network in the Ayeyarwaddy Region.

LITERATURE REVIEW

Value chain, as a concept, is based on the process view of an organization or a supply chain (Porter 1985). A value chain describes the transformation and the value-adding activities that a commodity undergoes. It defines the inputs, transformation processes, and outputs at each stage of the chain to bring a product through the different stages of production, distribution, marketing, and consumer delivery (i.e., the value chain structure) (Kaplinsky and Morris 2001).

Value chain activities require acquiring and consuming resources (e.g., money, labor, material) and determining the costs and profits of each actor participating in the supply chain network. The methodology has been applied to understand commodity chains and export strategies, especially in developing countries (Kaplinsky and Morris 2001). According to Trienekens (2011), a value chain analysis also requires mapping the major constraints in the opportunities and in the institutional environment of each actor in order to identify

the options that would upgrade the value chain network.

The constraints to value chain development are related to market access, market knowledge and orientation, the available resources and infrastructure, and institutions. Market access depends on the producers' technological capabilities, available infrastructures, bargaining power, and market knowledge and orientation. Market knowledge and orientation refer to the intelligent capturing of information about consumers' needs and how this knowledge is used to increase the added value of activities to upgrade the value chain (Grunert et al. 2005). However, constraints on resources and infrastructure (e.g., lack of specialized skills and difficulties in accessing technology, inputs, market information, credit, and external services) may obstruct this upgrade (Giuliani, Pietrobelli, and Rabellotti 2005).

The value chain in developing countries can be characterized as a local low-income chain. Producers are usually small, and they operate using traditional production systems. These chains include many intermediary parties that are relatively long. Thus, market information is limited, the added value is distributed over a large number of actors, and transportation and distribution problems are more profound (Trienekens 2011). Furthermore, upgrading can be hindered by government legislations, regulations, and policies by, for instance, setting trade barriers for production technology, limiting information flow, or denying infrastructure investments. According to Marti and Mair (2008), developing countries are often characterized by institutional voids; institutional policies and regulations are absent, weak, or fail to accomplish their roles. Accordingly, a facilitating government that supports innovation and upgrading is often considered conditional for development (Murphy 2007).

The following section reviews the relevant studies on value chain analysis in the rice industry in ASEAN countries and the rice value chain in Myanmar.

Rice Value Chains in Some ASEAN Countries

Different studies have reported on the value chain of the rice sector in ASEAN countries. In low-income countries (i.e., Cambodia, Lao PDR, and Myanmar), the rice industry is a crucial agriculture subsector and is important in terms of land use, farm income, and food consumption. Improving rice sector performance and developing the value chain is critical for reducing poverty in these countries (World Bank 2014).

Compared with the rice value chains in the neighboring countries Thailand and Vietnam, those in Cambodia, Lao PDR, and Myanmar are characterized by less efficient input supply systems, lower farm productivity and profitability, higher milling and export costs, and lower quality of exported rice (Zorya et al. 2016). As a result, rice value chains in Cambodia, Lao PDR, and Myanmar are less competitive than those in Thailand and Vietnam. Such situation is detrimental in the international market as Cambodia, Lao PDR, and Myanmar are net rice exporters and have much lower export volumes. In addition, the profits of the individual actors in the value chain in these countries are much lower due to lower yields, lower output prices, and higher production costs. Thus, rice farmers in these low-income countries are much more vulnerable than those in Thailand and Vietnam.

Zorya et al. (2016) argue that these low-income countries need to improve their value chains at all stages of the chain. In the production phase, farmers should increase their productivity and quality of paddy produced in a sustainable manner in light of the constraints on the available good-quality seeds and the lack of quality extension services. Rice millers who

process the paddy into rice need to reduce their costs through improving their process efficiency and quality and through increasing their processing capacity. Although many rice mills operate in these three countries, many of them are (too) small and deal with capital shortage problems due to the intense competition. In the distribution phase, Myanmar's export market relies too heavily on cross-border trade, and other countries should be exploited to increase rice export profitability. In recent years, Cambodia has made the most progress in the production, milling, and export segments, whereas Myanmar has lagged behind.
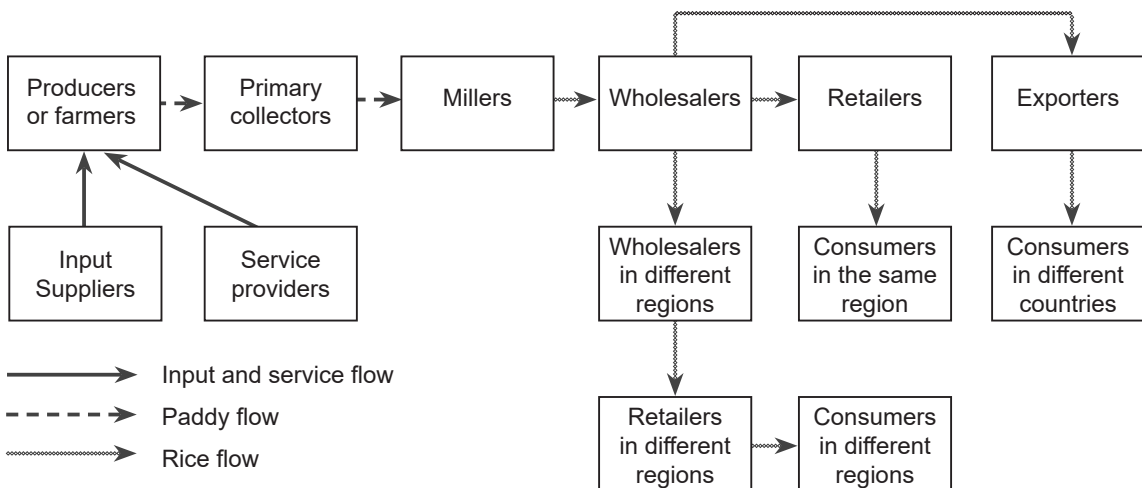
Rice Value Chain in Myanmar

Wong and Wai (2013) studied the rice value chain of Myanmar. Figure 1 shows the structure of the rice value chain in the research area, and this structure has been validated at the start of this study. The rice value chain starts from the supply of inputs (i.e., agrochemicals, machinery, seeds, credit, and extension services) to farmers for the paddy production. Cultivating paddy requires different activities, such as land preparation, sowing seeds, transplanting seedlings, weeding,

applying fertilizers and pesticides, harvesting, threshing, drying, winnowing, storage, and then selling the surplus after allowing for home consumption. The primary collectors buy the paddy from the farmers with the financial support of millers. The millers then give fees to the primary collectors and mill the paddy into rice. They carry out different activities that add value, such as transportation, processing, grading, and packing. The millers store and then distribute the rice mainly to wholesalers. Thereafter, wholesalers deliver the rice on their turn to retailers in order to supply the domestic consumers or exporters, who then supply consumers in foreign countries.

A study issued by the Ministry of Agriculture and Irrigation (MOAI 2015b) has cited that the rice value chain in Myanmar is not well integrated, and thus needs to be more efficient. There are (too) many different actors operating at each stage. Likewise, there are (too) many stages, ranging from individual farmers to large scale wholesalers and exporters. Several weaknesses characterize the different stages of the chain, which cause high transaction costs for all actors (World Bank 2014; Raitzer, Wong, and Samson 2015; MOAI 2015b).

Figure 1. Rice value chain structure in Ayeyarwaddy Region

For one, Burmese farmers have to deal with low-quality inputs (e.g., inferior input seeds and chemical fertilizers), poor water management, and inappropriate use of pesticides and herbicides. For another, rice farmers face seasonal labor shortages and lacks access to credit system to enable them to upgrade their operations. Meanwhile, the infrastructures of most millers (i.e., the milling machines and power supply) are outdated, costly, and unreliable, which lead to inferior rice quality that does not meet the standards for export.

Moreover, government efforts to improve investments in the rice industry are insufficient with respect to the following (San 2017):

1. infrastructure, such as multi-purpose dams, irrigation and drainage canals, and farm roads; and
2. agricultural support services, i.e., research, extension and credit, which is currently at Myanmar Kyat (MMK) 100,000 per acre with 0.045 percent interest rate.[1]

As a result, most of the actors in the supply chain lack capital to invest in production, processing, and distribution facilities (World Bank 2014; Raitzer, Wong, and Samson 2015).

METHODOLOGY

Data Collection and Sampling Technique

Both primary and secondary data on the rice value chain in Ayeyarwaddy Region, the main rice-growing area in Myanmar, were collected. Two townships in the region were chosen as the study areas, namely, Myanaung and Kyangin.

The respondents in the study areas were selected using purposive and stratified random sampling methods. The population was stratified based on their role in the supply chain. In each subpopulation, the random sampling method was used to form the test group. The sample size was calculated for each stratum in direct proportion[2] to the size of the stratum as compared to the (finite) population (Appendix Table 1) (Judez et al. 2006). As a result, a sample size composed of 130 farmers, 21 primary collectors, 25 millers, 7 wholesalers, 28 retailers, and 4 exporters was selected for face-to-face interviews. As a cross-sectional survey, in-depth and key informant interviews were used as data gathering methods in this study (Umberger 2014).

The primary data include the socioeconomic characteristics of the value chain actors, financial information about sales volumes and prices, transaction costs, and constraint information. Constraint information was gathered through a binary response questionnaire. Meanwhile, secondary data were collected from the Department of Agriculture; Ministry of Agriculture, Livestock, and Irrigation (MOALI);[3] Myanmar Rice Federation; FAOSTAT; and website and other relevant data sources.

Data Analysis Method: Sociodemographic, Financial, and Constraint Information

Descriptive statistics (i.e., mean, frequency, percentage, and range) were applied using the program Statistical Package for the Social Sciences (SPSS). The characteristics of the value chain, i.e., socioeconomic and constraint

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1   USD 1 = MMK 1,350
    1 km^2 = 247.105 acres

2   This is based on the equation of Yamane (1967) (i.e., $n = \frac{N}{1 = N(e^2)}$) where N is the population, e^2 is the standard error, and n is the sample size.

3   MOALI is the result of a 2016 merging among three agencies, one of which is the actual source of the data referred to here—the Myanmar Ministry of Agriculture and Irrigation (MOAI).

data of the sample respondents, were described based on the cross-sectional data obtained from the survey. We also used inferential statistics to describe and make inferences, to apply hypothesis testing, and to identify the significant differences between groups of actors in the value chain. Moreover, the concept of enterprise budget (Olson 2009) was used to evaluate the profitability of the actors. This enabled us to evaluate the cost and return of the value-adding activities.

In this study, the return above variable cost or the gross margin is calculated as follows

$$\text{(1)}$$

Return above variable cost = Total Gross Benefit − Total Variable Cost

The total variable cost takes into account material costs, hired labor costs, family labor cost, and the interest on cash cost. We determine the marketing costs, marketing margins, and marketing profits of the different actors in the value chain via the marketing cost and margin analysis applied by Raha and Akbar (2010), Maneechansook (2011), Miah (2013), and Abdullah et al. (2015), among others. In the method, the difference between the price of any product at one stage in the marketing process and the price of the equivalent product at another stage of marketing is called the marketing margin (Smith 1992), that is,

$$\text{(2)}$$

Gross marketing margin (GMM) = Selling price − Purchase price paid by an actor

and

$$\text{(3)}$$

Total gross marketing margin = Consumer price − Producer price

The net marketing margin or marketing profit is the percentage over the final price earned by the middleman as his or her income after deducting his or her marketing costs. The net marketing margin can be calculated as follows:

$$\text{(4)}$$

$$\text{Net Marketing Margin} = \frac{(GMM - \text{Marketing cost})}{\text{Consumer price}} \times 100$$

Data Analysis Method: Explanatory Factors of Actor Profitability

To obtain insights on the most important constraints in the value chain and the factors and characteristics of the value chain actors that significantly impact profitability, we use multiple linear regression analysis. Regression analysis is a statistical forecasting model that describes and evaluates the relationship between a dependent variable and a set of independent variables (Rawlings, Pantula, and Dickey 1998). A generic multiple linear regression model is presented as follows:

$$\text{(5)}$$

$$Y = \beta_0 + \sum_i \beta_i X_i + \mu$$

where:

Y	=	dependent variable,
X_i	=	independent variable,
β_0	=	constant,
β_i	=	coefficient of the independent variable, and
μ	=	error term.

EMPIRICAL RESULTS

This section presents the empirical findings that characterize the rice value chain in Myanmar. The first subsection discusses the profitability and the sociodemographic characteristics of the actors. The second subsection gives insights on the constraints encountered by the actors at each level of the rice value chain. The last subsection relates the sociodemographic and constraint information to the profitability of the actors in

the supply chain. Accordingly, the data analysis methods used in this study identified the most important constraints. Note that the presented empirical data applies only for the Emata rice varieties.

Characteristics of the Rice Value Chain in Myanmar

Profitability analysis

This subsection presents the empirical results related to the gross marketing margins and the marketing profits along the rice value chain. Note that paddy is marketed in the value chain from farmers to millers through the collectors. Millers transform the paddy into rice; thus, rice is marketed from millers through wholesalers to retailers or exporters.

In this calculation, the conversion of paddy into rice is estimated at 60 percent (Zorya et al. 2016). The profits and margins of paddy and rice used were calculated for domestic consumption (Table 1) and for export consumption (Table 2). This distinction is only apparent at the final stage of the value chain and is based on the distribution channel—whether the rice is distributed via retailers for domestic consumption or via exporters for export consumption.

The rice value chain is characterized by a wide marketing margin, i.e., a high consumer price for rice and a low farmgate price for paddy. The gross marketing margins and profits are not equally distributed over the different actors. In general, rice millers obtain the highest percentage of the profit share among the value chain actors at 50.9 percent for domestic consumer chain and 59.8 percent for international consumer chain. These values are significantly[4] higher than those of the other actors in the supply chain. This is because rice

millers purchase the paddy cheaply from the farmers at harvest time when paddy price is low. Thereafter, they add value by transforming the paddy into rice. Note that this margin of the rice millers may be biased upwards because only the variable costs are considered, whereas, capital investment costs are not. These capital investments are larger for millers than for the other actors in the value chain.

The farmers have the highest gross marketing margin at 44.1 percent for the domestic consumer chain and 43.3 percent for the international consumer chain. In contrast, their profit share amounts to only 9.0 percent and 10.6 percent, respectively. Hence, although the farmers have the highest margin, they have a lower profit than the millers do due to their higher production costs.

Sociodemographic characteristics

The empirical results on the sociodemographic characteristics of the respondents are presented in Table 3.

Gender. More male than female actors are involved in the rice supply chain. However, analysis revealed that in the distribution stages—by grouping the wholesalers, the retailers, and the exporters—there are significantly[5] more female actors in the supply chain.

Age. The mean age of the actors ranges from 41.6 years to 50.1 years. Statistical analysis revealed that primary collectors are significantly[6] younger than the other actors. No other differences are noted.

Family size. The mean number of family members is around four for all actors in the value chain. There are no other significant differences between the different groups.

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4   The applied test is F-test (p-value < 0.001). A post-hoc test (p-value < 0.001) is performed to analyze the pairwise differences between actors.

5   We conducted a chi-square test (p-value < 0.05).

6   The applied test is F-test (p-value < 0.05). A post-hoc test (p-value < 0.001) is performed to analyze the pairwise differences between the actors.

Table 1. Marketing profits and margins for domestic consumption

Actor	Cost (MMK/kg)			Revenue (MMK/kg)	Profit (MMK/kg)		Margin (MMK/kg)	
	Unit Total Cost	Unit Added Cost	% Added Cost	Unit Price	Unit Marketing Profit	% Total Marketing Profit	Unit Marketing Margin	% Total Marketing Margin
Farmer	210	210	77.5	236	26	9.0	236	44.1
Primary collector	236	0	0.0	241	5	1.7	5	0.9
Miller	255	39	14.4	402	147	50.9	161	30.1
Wholesaler	413	11	4.1	448	35	12.1	46	8.6
Retailer	459	11	4.1	535	76	26.3	87	16.3
Total		271	100.0		289	100.0	535	100.0

Notes:

(1) USD 1 = MMK 1,350

(2) The conversion ratio of paddy to rice is 0.60.

(3) Unit total cost of miller = unit price of primary collector − return from byproduct + unit added cost = 255 = 241 − 25 + 39

(4) Unit marketing margin = selling price per unit − purchase

Unit marketing profit = unit marketing margin − total production/transformation/ distribution cost per unit

% Total marketing profit = (marketing profit per unit of each actor/total marketing profit per unit of all actors) × 100

% Total marketing margin = (marking margin per unit of each actor/total marketing margin of all actors) × 100

Table 2. Marketing profits and margins for export consumption

Actor	Cost (MMK/kg)			Revenue (MMK/kg)	Profit (MMK/kg)		Margin (MMK/kg)	
	Unit Total Cost	Unit Added Cost	% Added Cost	Unit Price	Unit Marketing Profit	% Total Marketing Profit	Unit Marketing Margin	% Total Marketing Margin
Farmer	210	210	64.8	236	26	10.6	236	43.3
Primary collector	263	0	0.0	241	5	2.3	5	0.9
Miller	255	39	12.0	402	147	59.8	161	29.5
Wholesaler	413	11	3.4	448	35	14.2	46	8.4
Exporter	512	64	19.8	545	33	13.4	97	17.8
Total			100.0		246	100.0	545	100.0

Notes: (1) USD 1 = MMK 1,350

(2) The conversion ratio of paddy to rice is 0.60

(3) Unit total cost of miller = unit price of primary collector − return from byproduct + unit added cost = 255 = 241 − 25 + 39

Table 3. Sociodemographic characteristics of the rice value chain actors

Indicator	Unit	Parameters	Farmer	Primary Collector	Miller	Wholesaler	Retailer	Exporter
Gender	Numbers	Male	114 (6.20)	19 (10.3)	23 (12.5)	5 (2.7)	19 (10.3)	4 (2.2)
		Female	16 (15.5)	2 (6.5)	2 (6.5)	2 (6.5)	9 (29.0)	0
Age	Years	Mean	51.1	41.6	50.1	46.7	49.9	43.0
		Min	27.0	25.0	30.0	41.0	30.0	35.0
		Max	85.0	60.0	66.0	62.0	72.0	50.0
Family size	Numbers	Mean	4.0	4.0	4.4	4.0	3.6	4.0
		Min	2.0	1.0	2.0	2.0	2.0	3.0
		Max	8.0	7.0	8.0	6.0	6.0	6.0
Education	Schooling	Mean	6.6	9.3	11.0	12.3	9.9	15.0
	Years	Min	2.0	5.0	5.0	6.0	4.0	15.0
		Max	15.0	15.0	15.0	15.0	18.0	15.0
Work Experience	Years	Mean	27.1	10.8	12.8	13.0	13.6	13.0
		Min	3.0	1.0	1.0	3.0	1.0	5.0
		Max	54.0	33.0	33.0	24.0	50.0	26.0

Note: Figures in parenthesis represent percentage.

Education. The education of actors enhances their decision making and their basic communication abilities with any support service providers (e.g., extension officers and other stakeholders). Education is expressed by the number of schooling years, which ranges from 6.6 years for farmers (corresponding to the secondary education level) to 15 years for exporters (corresponding to graduate level). The education level of farmers is significantly[7] lower than those of the other actors. In general, the further upstream in the value chain and the more the involvement in the processing and marketing activities, the higher the education level is apart from the retailers.

Work experience. Farmers have the most years of working experience (27.1 years), whereas primary collectors have the least (10.8 years). Millers, wholesalers, retailers, and exporters have around 13 years of work experience. Farmers' work experience is significantly[8] higher than those of the other actors.

Constraints in the rice value chain

This portion gives insight on the constraints faced by each actor along the rice value chain in the study area. These constraints, possibly imposed by external parties, hinder them from improving the value chain. In particular, the constraints are categorized into material input constraints, production constraints, financial constraints, and distribution and institutional constraints.

Farmers. Farmers encounter many different types of constraints (Figure 2). Results of the survey showed that most farmers face different material input constraints, i.e., seed impurity (63.8%), inadequate use of fertilizers (51.5%), and poor input quality of fertilizers,
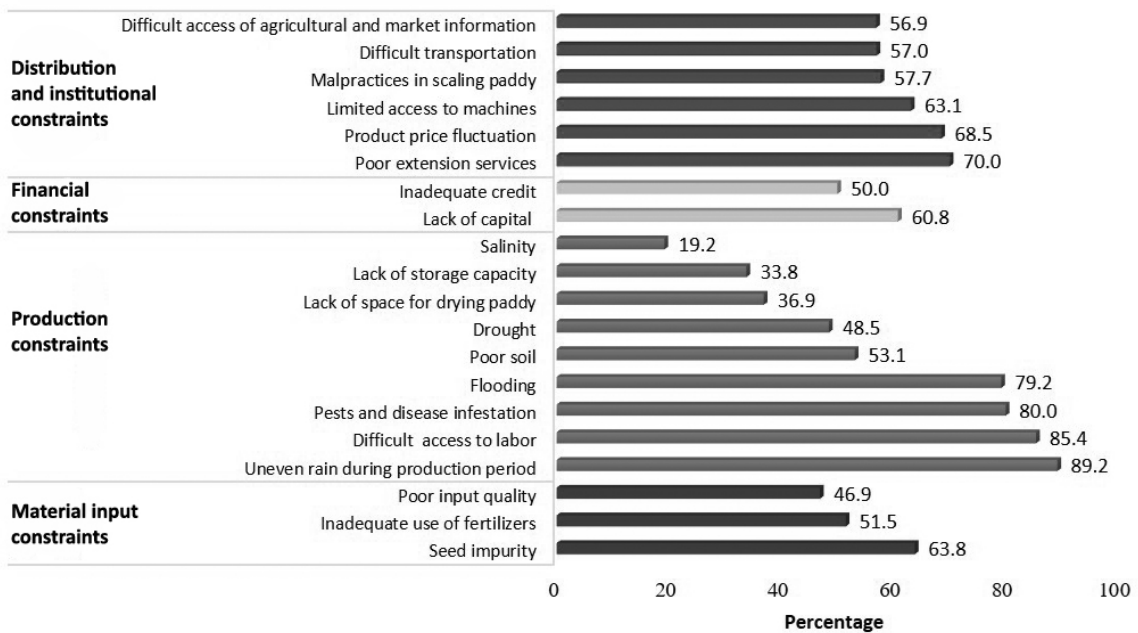
pesticides, insecticides, and chemicals (46.9%). From the in-depth interviews, the respondents said that they have insufficient know-how with regard to the quality of these agrochemicals, which is required to improve productivity and product quality.

Meanwhile, we identified nine different production constraints, five of which are weather-related, such as uneven rain during the production period (89.2%), flooding (79.2%), drought (48.5%), salinity (19.2%), and pest and disease infestation (80%). Further, farmers suffer from labor scarcity (85.4%), which increases labor cost and crop wastage. Financial constraints hinder farmers from modernizing their farming process or product quality; about 61 percent and 50 percent of the farmers lack capital and access to credit, respectively.

Farmers also complained about revenue losses as a result of distribution constraints, i.e., fluctuations in paddy prices (68.5%) and inappropriate scaling, weighing, and deduction when selling their goods (57.7%). More than 50 percent of the farmers identified transportation problems resulting from poor road infrastructure, especially during the rainy season. Institutional constraints, on the other hand, involve farmers' difficulty in accessing extension services (70%) and new agricultural technologies and market information (56.9%). About 63.1 percent of the farmers are not able to invest in agricultural machinery (soil preparation machines, high-technological seeders, intercultivators for weeding, etc.) because of the lack of capital and insufficient support both from government and non-government organizations.

Primary collectors. Figure 3 shows that primary collectors face only a few constraints. They could obtain a higher profit if they have sufficient capital to buy paddy at a low price; thereafter, they can store and sell the paddy when the price is higher. However, 28.6 percent of the primary collectors face capital shortage and 14.3 percent have limited access to credit.
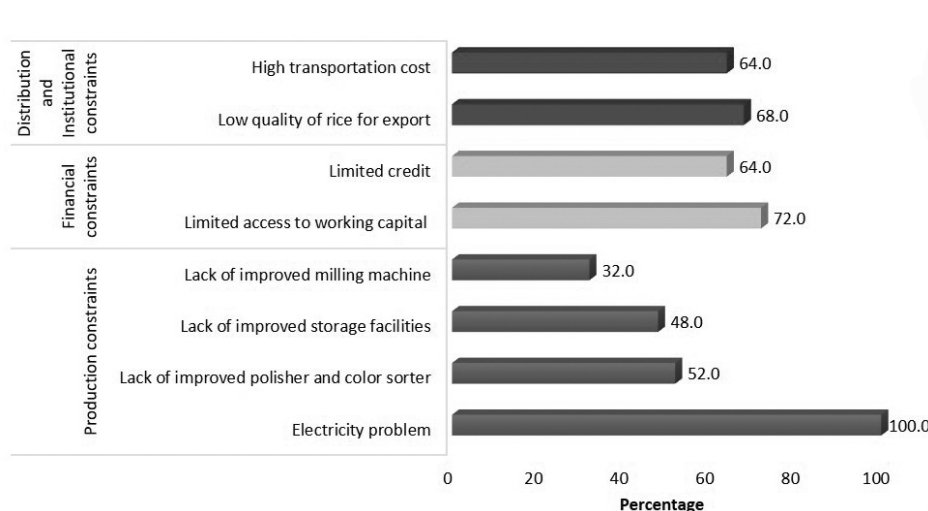

7,8   The applied test is F-test (p-value < 0.001). A post-hoc test (p-value < 0.001) is performed to analyze the pairwise differences between the actors.

Figure 2. Operational constraints of farmers

Figure 3. Operational constraints of primary collectors

The major distribution and institutional constraints are related to road infrastructure (71.4%) and poor paddy quality (66.7%).

Millers. Meanwhile, Figure 4 reveals that millers face different production constraints, making it difficult for them to improve productivity and the quality of r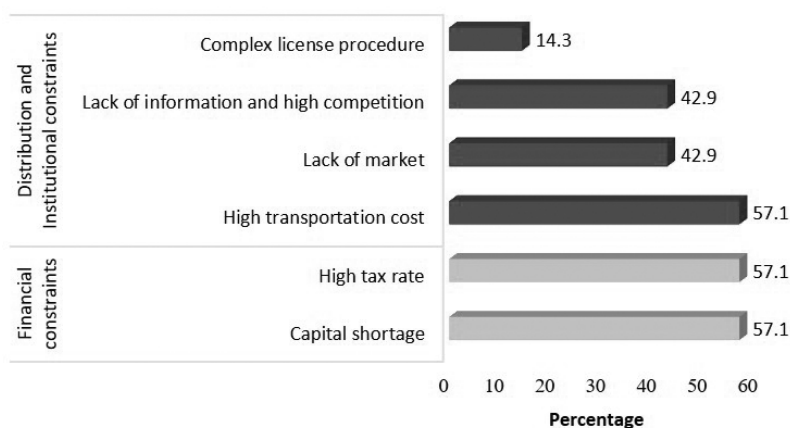ice they produce. All millers encounter problems with power supply. Most of the rice millers surveyed pointed out that their milling machines are outdated, which leads to frequent machine breakdowns; they also need skillful mechanics to repair these machines. About 52 percent of the rice millers lack improved polisher and color sorter to improve rice quality. Almost half (48%) indicated that they do not have suitable storage facilities.

Figure 4. Operational constraints of millers

Financial constraints also restrict their operations since most of the millers (72%) have limited access to working capital. The small-scale rice millers, in particular, cannot collect the required amount of working capital. Distribution constraints, on the other hand, include poor road infrastructure and high transportation cost due to high fuel costs and road toll fees. About 68 percent of the rice millers wish to export their rice to other countries directly, but they claimed that their rice quality is too low for export, and this is mainly due to seed impurity, a high proportion of broken rice, and improper handling by the farmers.

Wholesalers. The survey results in Figure 5 reveal that wholesalers face financial, distribution, and institutional constraints. Wholesalers need more capital to run or expand their businesses. However, they are short in capital due to high interest rates, high tax rates, and difficulty in accessing loans, which create deficiencies in the value chain. Moreover, they face high transportation costs, lack adequate

Figure 5. Operational constraints of wholesalers

market infrastructure and market information, and suffer from high competition.

Retailers. Retailers encounter financial, distribution, and institutional constraints as well (Figure 6). Most of the sampled retailers need more capital to expand their businesses, but they are not able to collect the required credit from third parties. They operate in small, daily markets where they have to pay a fee and are imposed with high taxes to sell their goods. They likewise suffer from high competition, possibly against unlicensed retailers. Moreover, some of the retailers have to order different rice varieties from other regions depending on the preferences of the consumers. They also do not have enough storage space. Other constraints are poor roads and market infrastructure.

Exporters. Exporters need to process rice to reach the required quality standards. In this process, electricity or power interruption is a major problem, which consequently lengthens the processing time. Exporters encounter financial constraints as they face high interest rates when they borrow money from banks (Figure 7). Some of the exporters suggested for the government to provide loans with low interest rates, similar to those provided by other countries. The banks in Myanmar are outdated, and exporters find it difficult to process

financial transactions to other countries. In these transactions, fluctuations in exchange rate is also a problem since they impact on the prices of rice. All exporters face high logistic costs and transportation costs stemming from distribution and institutional constraints. As a result of all these factors, rice exporters in Myanmar find it difficult to compete with exporters from other rice countries.

Impact of operational constraints on profitability

In this section, we identify via a multiple regression analysis the most significant operational constraints that impact the profitability of the different actors in the value chain. The sociodemographic characteristics of the respondents are included in this analysis to make the findings more accurate. The operational constraints and gender characteristic are modeled via binary response variables. The other variables (i.e., age, work experience, education, and family size) are modeled as integer variables. This analysis could not be done for exporters because of the limited number of exporters in the region, and for primary collectors since they all have exactly the same profit per unit. In our analysis, only the significant factors are mentioned.

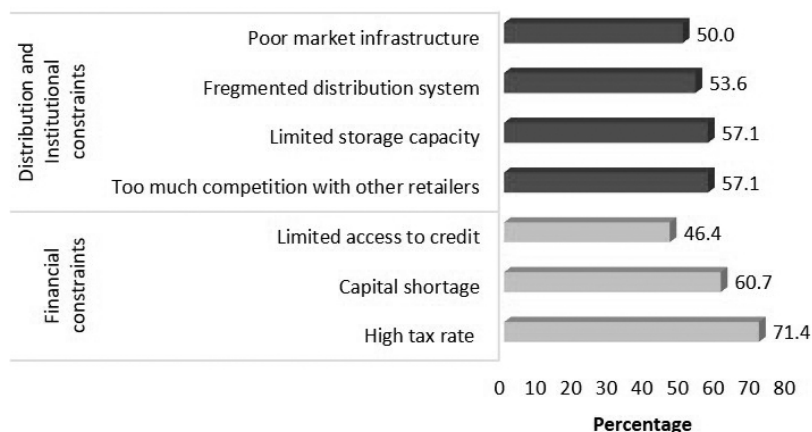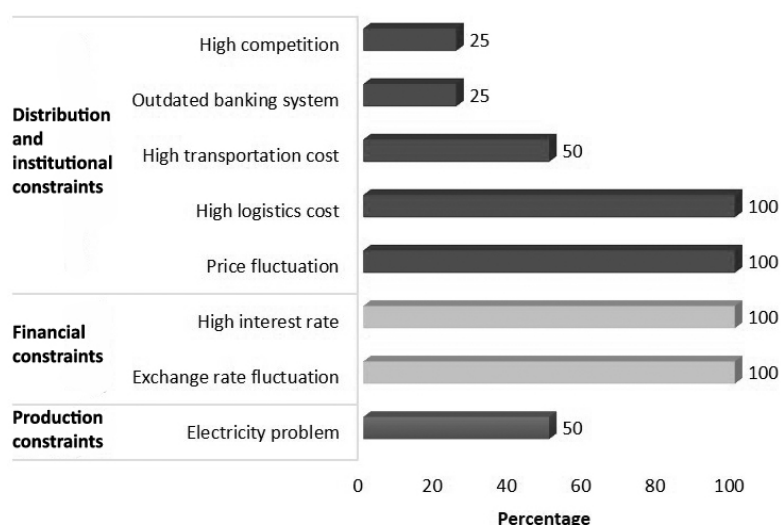**Figure 6. Operational constraints of retailers**

Figure 7. Operational constraints of exporters

Farmers. The results of the regression analysis of the farmer profitability are displayed in Table 4. Constraints resulting from natural disasters (i.e., flooding, natural pests and diseases, and uneven rain during production period) have the largest impact on farmers' profitability. Farmers who suffer from natural disasters have a significantly lower profit. The correlation analysis also revealed that material and/or labor input constraints, i.e., seed impurity ($p < 0.001$), poor input quality ($p = 0.001$), inadequate use of fertilizer ($p = 0.035$), and difficult access to labor availability ($p = 0.025$), significantly and negatively impact farmers' profits. The same is valid for the various financial and distribution and institutional constraints, i.e., the lack of capital ($p = 0.026$), product price fluctuation ($p = 0.009$), difficult transportation ($p < 0.001$) and poor extension services ($p = 0.011$).

The analysis of the sociodemographic characteristics revealed that farmers' age, education level, and work experience have a significant relationship with profitability and can impact how farmers perceive some constraints. Younger farmers earn more profits than older farmers do; the former tend to accept new or higher production technologies more easily to increase their productivity. The higher the level of education is, the higher the profit would be. Farmers with higher education tend to use their scarce resources more efficiently and effectively than the less educated ones (Duy 2015; Khai and Yabe 2011; Linh 2012). Likewise, they are better able to adopt higher technologies in rice production (Ghimire, Huang, and Shrestha 2015; Mariano, Villano, and Fleming 2012). Further, more experienced farmers earn more profits since they have been able to optimize their operations over the years.

Millers. Table 5 displays the estimated coefficients of the factors that impact rice millers' profits. Note that 84.2 percent of the variance in the millers' profits can be explained by the independent variables included in the regression model, which indicates that the model is able to obtain an accurate profit prediction. Rice millers' operations are negatively impacted by financial constraints and distribution and institutional constraints. High transportation costs have the largest impact on profit ($p = 0.002$). Millers who obtain lower-quality rice are not able to distribute their commodity to exporters, which leads to lower profits ($p = 0.061$).

Table 4. Estimated regression coefficients of factors influencing the profitability of farmers

Variables	Coef.	t-value	Sig.
Constant	77.537	1.286	0.201ns
Gender of actors (1 = male, 0 = female)	37.73	1.614	0.109ns
Age of actors (years)	−2.687	−3.063	0.003***
Family size (number)	−2.573	−0.464	0.644ns
Education of actors (schooling years)	7.717	2.381	0.019**
Working experience (years)	2.829	3.278	0.001
Flooding (1 = yes, 0 = no)	−96.293	−5.093	0.000***
Uneven rain during production period (1 = yes, 0 = no)	−40.667	−2.119	0.036**
Pests and diseases infestation (1 = yes, 0 = no)	−48.458	−2.159	0.033**
Difficult transportation (1 = yes, 0 = no)	−1.721	−0.079	0.937ns
Poor extension services (1 = yes, 0 = no)	−9.692	−0.432	0.667ns
	R = 0.719		
	R2 = 0.518		
	Adjusted R2 = 0.477		
	F-value = 12.777		0.000***

Notes: (1) *** = significant at 1 percent level   ** = significant at 5 percent level

ns = not significant

(2) Multicollinearity problem is not encountered in the model. All predictors of the value chain actors have variance inflation factor (VIF) of less than 5.

(3) The overall model is statistically significant at 1 percent level as indicated by the F-value = 12.77.

Likewise, their limited access to working capital and credit impacts profit (p = 0.047) since millers who are short in capital cannot purchase new technology to improve productivity. There is, however, a significant and positive relationship with some sociodemographic factors such as the number of schooling years (p = 0.001) and work experience (p = 0.055). More educated millers tend to adopt modern milling methods much more easily than the less educated ones, which leads to higher productivity and profit. In addition, more experienced millers are more skilled to lead their operations and are able to attain larger profit margin.

Wholesalers. Due to the small sample size, we could not do a regression analysis; instead, correlation analysis is used. Results showed that wholesalers suffer from limited access to working capital (p = 0.040) to expand their business and from high transportation costs (p = 0.014).

Retailers. Table 6 reports the results of the regression analysis for the retailers. Note that the independent variables included in the analysis explain 83.4 percent of the variance, and are thus able to predict the retailer profit in an accurate manner. Similar to the results of the other actors, retailers' profits are impacted by financial, distribution, and institutional constraints. Retailers imposed with high taxes and other fees have significantly lower profit (p = 0.030). Moreover, retailers obtain lower profit when they face severe competition (p = 0.010). Further analysis of the sociodemographic factors showed that more educated and experienced retailers tend to be more competitive. The higher the level of education, the higher the level of advanced knowledge to market rice, which consequently leads to higher profits (p = 0.037). Retailers with more work experience are more skilled than the less experienced ones and earn higher profits (p = 0.006).

Table 5. Estimated regression coefficients of factors influencing the profitability of the millers

Variables	Coef.	t-value	Sig.
Constant	118.462	3.912	0.001
Gender of actors (1 = male, 0 = female)	13.996	0.979	0.343ns
Age of actors (years)	−0.044	−0.114	0.911ns
Family size (number)	2.393	0.790	0.442ns
Education of actors (schooling years)	4.214	4.376	0.001***
Working experience (years)	1.129	2.081	0.055*
Capital shortage (1 = yes, 0 = no)	−16.796	−2.159	0.047**
Low quality of rice for export (1 = yes, 0 = no)	−16.119	−2.027	0.061*
Lack of improved rice huller and polisher (1 = yes, 0 = no)	−4.326	−0.631	0.538ns
High transportation cost (1 = yes, 0 = no)	−25.622	−3.652	0.002***
	R = 0.918		
	R2 = 0.842		
	Adjusted R2 = 0.747		
	F-value = 8.886		0.000***

Notes: (1) *** = significant at 1 percent level   ** = significant at 5 percent level
           ns = not significant

(2) Multicollinearity problem is not encountered in the model as all predictors of the value chain actors have VIF < 5.

(3) The overall model is statistically significant at the 1 percent level as indicated by the F-value = 8.886.

Table 6. Estimated regression coefficients of factors influencing the profitability of the retailers

Variables	Coef.	t-value	Sig.
Constant	46.24	1.930	0.70*
Gender of actors (1 = male, 0 = female)	0.087	0.254	0.802ns
Age of actors (years)	−6.074	−1.044	0.310ns
Family size (number)	−0.231	−0.080	0.937ns
Education of actors (schooling years)	1.784	2.258	0.037**
Working experience (years)	0.923	3.082	0.006***
Faced with poor infrastructure (1 = yes, 0 = no)	2.832	0.479	0.637ns
Capital shortage (1 = yes, 0 = no)	−5.287	−0.911	0.374ns
High taxation and other fees (1 = yes, 0 = no)	−17.211	−2.357	0.030**
Too much competition with other retailers (1 = yes, 0 = no)	−19.925	−2.859	0.010***
	R = 0.913		
	R2 = 0.834		
	Adjusted R2 = 0.751		
	F-value = 10.071		0.000***

Notes: (1) *** = significant at 1 percent level   ** = significant at 5 percent level
           ns = not significant

(2) Multicollinearity problem is not encountered in the model as all predictors of the value chain actors have VIF < 5.

(3) The overall model is statistically significant at the 1 percent level as indicated by the F-value = 10.071

DISCUSSION

The rice value chain in Ayeyarwaddy Region is characterized by a large number of steps and operational constraints that hinder the profitability and development of the rice value chain. The structure of the value chain in the region is similar to that in Cambodia (Kula, Turner, and Sar 2015). In Thailand, however, Maneechansook (2011) revealed that Thai farmers have cooperatives and brokers who operate in the national and international markets as intermediary parties. These actors improve market access and market knowledge and have made the rice industry in Thailand more competitive, which is mainly due to the increased bargaining power at the different stages of the value chain. In the studied region, the gains are not distributed equally among the actors. Millers obtain the largest profits; although farmers gain profits, theirs is much lower than the other actors'. The study of Maneechansook (2011) came to similar conclusions with regard to the rice industry in Thailand. However, the profits are more balanced between the actors and are relatively higher for farmers and intermediary parties.

The profits and potential upgrade of the value chain depend heavily on the operational constraints existing at each stage of the value chain. In the following, we will discuss the challenges associated with the constraints that have been identified in this study as the most important at each stage of the value chain and the constraints that are returning at different stages.
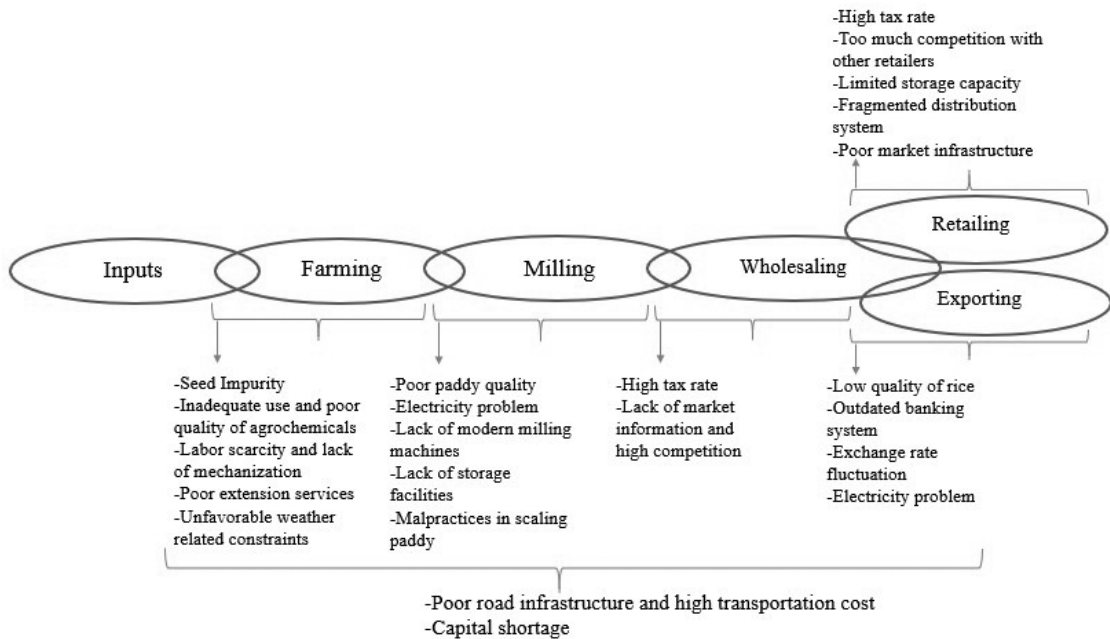
Figure 8 gives an overview of the challenges to the rice value chain in Myanmar. In addition, we pinpoint the parties from the government, private sector, development partners, and civil society that are best placed to help address these constraints.

Farmers and Their Inputs

The analysis revealed that although farmers are vital in the value chain as rice producers, they are the most vulnerable in the chain as they are exposed to many constraints. These constraints are in line with available literature (De Janvry and Sadoulet 2005; Reardon and Barret 2000), which state that farmers in developing countries have competitive disadvantage because they have limited capital, use traditional techniques, depend on family labor, and lack contact with (international) market players.

Farmers in the Ayeyarwaddy Region are foremost impeded by natural disasters. Unfavorable weather conditions (e.g., flooding, uneven rain) cannot be avoided. However, based on the dialogues conducted with the stakeholders, risk mitigation strategies should be developed and different actions should be done to improve farmers' yield. Public awareness of the impact of climate conditions on the agricultural production systems needs to be prioritized and mitigating technologies must be developed. Accordingly, such initiatives will require increased public and private investments. Accurate weather forecasts are crucial to farmers such that they can organize their activities proactively. In this regard, the Department of Agriculture and the Department of Meteorology should educate farmers via extension services on how to effectively use weather information for their agricultural activities and how to deal with adverse climate conditions. Information on best practices (e.g., adjusting cultivation period, using flood-resistant rice varieties, etc.) should be widely spread among the farmers in the region. In addition, government and private sectors should offer new financial climate crop insurance mechanisms to protect the farmers.

The second major type of constraint is related to input materials. Seeds, agrochemicals, etc. significantly impact productivity and rice quality. This particular constraint is identified in the later stages of the chain to be a restrictive

Figure 8. Overview of the operational constraints in the rice value chain in the study area

factor in improving the value chain and in increasing the actors' profits. Good-quality and pure seeds are essential to increase yield and improve the quality of rice production so that Myanmar can become a significant rice exporter in the global market. However, the seeds that Burmese farmers use are impure because they produce the seeds in their own farms using traditional methods. This finding is in line with the results of Wong and Wai (2013). As such, (state) seed production companies need to reform their operations so that all farmers can have access to high-quality seeds at the least possible cost.

Other improvements can be realized through better regulation of price and quality of agrochemicals (e.g., fertilizers, pesticides, and herbicides). Currently, very expensive, unregistered and/or banned agrochemicals enter the input market in Myanmar; this has been confirmed by Wong and Wai (2013), and Rong (2013) had similar findings in Cambodia. Therefore, the government needs to strictly implement the Fertilizer Law and the Pesticide

Law. Agrochemical products that enter the market should be regulated and registered to ensure that the quality standards are met. In addition, farmers, through extension services, should be better educated and should learn more about the quality of agrochemicals and how they should be used.

Labor shortage and traditional farming further hinder rice farmers' production. Accordingly, this could be addressed through promoting and adopting farm mechanization in land preparation, cultivation, and postharvest. Therefore, the government should initiate farm mechanization and cultivation programs, in cooperation with private institutions, such that farmers can be provided with

1. appropriate (public) infrastructure ready for mechanization,
2. knowledge transfer to educate farmers on how to adapt their farm and farming techniques, and
3. access to credit with low interest rates to enable farmers to acquire farm machinery.

Most of these constraints could be addressed if more and better agricultural extension services are offered to farmers. These same recommendations have been given by Rong (2013) and Wong and Wai (2013). Accordingly, the main responsible institution for this is MOALI; MOALI could then partner with NGOs and private agrochemical companies so that extension education programs can be delivered to farmers more efficiently. Moreover, the extension system in Myanmar needs to be reformed, i.e., the mobility of extension officers should be increased; the links between farmers, researchers, and extension staff should be improved; and farmers should be encouraged to learn the latest technologies and new skills required for the new global agricultural era.

Millers and Their Inputs

Millers take a prominent place in the rice value chain in Ayeyarwaddy Region as results indicated that they obtain the largest profit share. Generally, the operational constraints hindering the millers' operations have a smaller impact on their profit as compared with those of farmers. However, in order to increase the competitiveness of the rice value chain, different constraints should be responded to.

In general, rice millers' infrastructure is insufficient and outdated. For one, the frequent power outages during the milling process severely impede millers' operations, thereby preventing from increasing their productivity. The government then needs to modernize the country's power infrastructure. In addition, storage facilities are insufficient to properly store large amounts of rice. Many millers also use outdated machinery to process rice, which leads to inferior rice quality. The same case has been observed in Cambodia (Rong 2013). Millers, however, cannot invest in storage facilities and high-quality modern milling machines due to financial constraints, i.e., capital shortage and high interest rates for loans. Moreover, the

paddy delivered by the farmers is often of lower quality due to farmers' inappropriate cultivation and postharvest drying practices. As a result, a high percentage of the commodity is broken after the milling process due to outdated milling machines (Rong 2013; Wong and Wai 2013).

Lastly, a standard weighing system that is fair to all stakeholders is likewise not in place; establishing such a system would considerably smoothen the production flow in the rice value chain.

Wholesalers and Retailers

Wholesalers and retailers function as intermediaries in the supply chain, albeit in a confined capacity. The taxes imposed on them relate to business licenses, marketing licenses, municipal taxes etc. However, the analysis showed that these payments are too high relative to their profits. As a result, many unlicensed retailers operate in the market, creating a more severe competition. Further, market information is very fragmented among the different companies because horizontal and vertical cooperation are lacking in the value chain. Market price information from the nearest market, supply/demand situation from focal point, and policy environment are important factors in the wholesaler's decision-making process. Therefore, intermediary parties should centralize correct and real-time market information in order to make the supply chain function more efficiently.

Exporters and Their Inputs

Exporters operate in the international market where revenues and value can increase significantly, similar to that experienced by Myanmar's neighboring ASEAN countries. However, several operational constraints hinder Myanmar rice exporters from upgrading and increasing their competitiveness in the international market. The low yield and low

quality of rice produced in Myanmar are the main constraints inhibiting the growth of the country's rice export market—both are not up to standard. Myanmar has an increasing demand from the international market for a rich diversity of traditional rice varieties, which have a high branding and marketing potential. In view of these, all stakeholders in the chain need to synergize their responsibilities and efforts to improve rice productivity and quality standard.

Exporters also face a different kind of financial constraint in their international transactions—difficulty in international financial transactions, higher interest rate in the local banks as compared with those of international banks, exchange rate fluctuations that cause price fluctuations in the entire supply chain, and an unstable market structure. Therefore, the government needs to implement reforms in the country's banking system, in cooperation with the banking sector, and develop an effective monetary policy.

The Entire Supply Chain

One major constraint inhibiting the actors in the rice value chain of Ayeyarwaddy Region from working more efficiently is the lack of financial means, particularly credit or working capital. All actors in the supply chain experience this constraint. For one, farmers need affordable paddy loans for land preparation and for input materials; this is the main responsibility of the Myanmar Agricultural Development Bank. On the other hand, farmers, millers, and distributors (wholesalers, retailers, and exporters) all need low-interest investment credits to modernize and expand their operations and infrastructure. Credits should be provided by banks in cooperation with the government and interested private partners.

Moreover, the different actors in the supply chain, especially those in marketing and distribution, suffer from difficult transportation and high transportation and logistics costs due to poor road access and high fuel costs. As such, the government in cooperation with the private sector, should modernize the road infrastructure in the region in order to improve its reliability and minimize transportation costs.

CONCLUSIONS AND RECOMMENDATIONS

The value chain of the rice supply chain in Ayeyarwaddy Region, Myanmar is structurally inefficient, characterized by a large number of actors who face numerous constraints. Gross marketing margin across the global value chain is very wide, and is not equally distributed among the different actors. Not all actors receive a reasonable profit margin. Rice millers are by far the most profitable actors, whereas, farmers are the most vulnerable in the value chain given their moderate profit margin and large number of constraints. The actors suffer from constraints of material input, production, financial, distributional, and institutional nature. All these limitations have significant and negative impacts on profitability that hinder the development of the value chain. The identified constraints highlight the array of key issues that must be addressed to improve the country's rice value chain. However, priorities should be set to accomplish a feasible and gradual progress of the value chain.

First, stakeholders need to improve the quality of rice. The government and private partners are responsible for ensuring that high-quality production inputs (i.e., seeds, fertilizers, chemicals) are available. Accordingly, the government should strictly enforce quality control over these inputs.

Moreover, farmers could also be encouraged to learn about modern cultivation and post-harvest techniques, climate risk mitigation strategies, and new technologies through

the government's extension services. The government needs to invest in such extension programs by providing trainings to extension staff and by providing sufficient logistical support. At the same time, farmers and the other actors in the value chain could organize and establish cooperatives in order to increase their bargaining power, both in the local and international markets similar to those done by other ASEAN countries. Price fluctuations would then be less volatile, more accurate market information could be gathered, and a better market orientation would be obtained—all of which are essential for the value chain to function effectively.

Second, investments at each stage of the supply chain are needed as the rice value chain in the study area is still very traditional. Therefore, the actors need sufficient working capital, which could be acquired through the previously recommended actions, or should be provided with easier and wider access to loans from banks, private parties, or the government. As such, farmers and millers would be able to mechanize their operations to significantly increase rice production and further improve the quality of their commodity. These loans will also allow distributors to expand their businesses.

Third, the government, in collaboration with the private sector, needs to invest in the existing road, power, and market infrastructures. Upgrading the road network will increase market access and avoid inefficiencies in transport and logistics. This will reduce transportation costs and increase market competitiveness.

Lastly, future research should focus on how the rice value chain of Myanmar can be further developed. Determining a benchmark of the efficient practices of actors could enhance the productivity, profit, and the amount of rice marketed by the entire value chain. Therefore, the efficiency of the actors should be evaluated and compared. Best practices

should be disseminated via extension services. Moreover, productivity and product quality of the agricultural value chain is heavily affected by uncertainties, which may even cancel out the intended effect of government or private policies. Therefore, the main sources of uncertainty encountered by the different parties in the rice supply chain should be identified.

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Appendix Table 1. Sampled respondents in the rice value chain, Ayeyarwaddy Region, Myanmar

Actors	Townships	Total Population	Sampled Respondents
Farmers	Myangaung (Laharpauk village)	399	30
	Myangaung (Htanthonepin village	327	30
	Kyangin (Kyantaw village)	663	35
	Kyangin (Sonehle village)	630	35
Collectors	Myangaung	105	15
	Kyangin	60	6
Millers	Myangaung	132	18
	Kyangin	80	7
Wholesalers	Myangaung	34	4
	Kyangin	20	3
Retailers	Myangaung	103	20
	Kyangin	61	8
Rice exporters	Yangon	36	4