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PROSPECTS FOR THE MYANMAR RUBBER SECTOR: AN ANALYSIS OF THE VIABILITY OF SMALLHOLDER PRODUCTION IN MON STATE

By

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Table of Content

Tables

Figures

1. INTRODUCTION

After nearly three decades of isolation from the world economy, Myanmar is moving forward with political and economic reforms. As a result of this political and economic transformation Myanmar has tremendous opportunities for growth. Although agriculture accounts for the largest share of employment in Myanmar, its contribution to GDP is small. Myanmar's agriculture value chains are underdeveloped; smallholder capacity is low and investment in the agriculture sector has been limited. At the same time, Myanmar's geographic position and climate make agriculture a potential driver for growth and development. In particular, Myanmar is well positioned to become a large exporter of rubber. Large parts of the high rainfall areas in eastern and southeastern Myanmar are well-suited for rubber cultivation. Following a gradual liberalization of the agriculture sector in the 1990s and a surge in rubber prices in international markets in the2000s, there was a surge in smallholder investment. Although yields remain low, they have risen substantially over the past two decades.

The world rubber market is also conducive to the expansion of the Myanmar rubber sector. Natural rubber consumption is projected to grow by two percent per year slightly lower than the four percent per year growth rate in the 2000s (Figure 1). As a result of China's economic slowdown, the sector has faced reduced demand in recent years (2012-2016), compared with the previous period (2008-2011). World demand is expected to pick up once again as a result of growth in lower-middle income countries and sustained demand in China, the United States, and Japan, the three largest importers of rubber (International Rubber Study Group, 2015). With movement away from rubber production in Malaysia and Singapore, and limited scope for rubber expansion in Indonesia, Myanmar could become an important rubber exporter.

Although rubber prices have fluctuated significantly in the most recent period 2000-2015, moving forward, rubber prices are projected to increase by five percent per year. In December, 2001, rubber prices reached $.53/kg, a fifty year historical low in real terms (Figure 2). In the following years, rubber prices increased substantially, jumping to $6.0/kg in real terms in May 2011, an historical high in fifty years. After this spike, prices immediately fell again to a low of $1.02/kg in February 2016. Despite this drop, the World Bank's commodity price projections suggest that the 2016 nominal price of $1.50/kg will rise to $1.90/kg in five years, providing Myanmar with another reason to invest in their rubber sector.

Despite, these opportunities, Myanmar faces challenges such as low rubber productivity and poor rubber quality. Further, these challenges are not concentrated in one segment of the value chain, but span across it. First, poor farming, tapping and processing methods lead to low yielding, low quality rubber. Second, institutional support for rubber production is lacking; smallholders have barley advanced their tapping and processing techniques over the past decade. Third, Myanmar has weak quality standards and certification processes for rubber processers and therefore farmers and processors receive discounted prices for their rubber. Lastly, there is a lack of an integrated rubber strategy on the part of the government.

While the rubber sector's current contribution to GDP is less than one percent, the growth of the sector could have an important socioeconomic impact and become a driver of job creation. Myanmar, by tackling structural weaknesses plaguing its rubber sector and focusing on

increasing production could become an important rubber producer. However, if these weaknesses are not addressed, its rubber sector may not just stagnate, but rather collapse.

In this paper we examine the profitability of smallholder rubber production in Mon State utilizing data from the Mon State Rural Household Survey (MSRHS) conducted from May to June 2015. This survey included 1,627 households and 7,262 members in 10 townships in Mon State (Rural Livlihoods in Mon State: Evidence from a Representative Household Survey, 2016). This paper also draws on qualitative data collected from rubber producer focus groups in Mon, as well as other interviews with rubber producers, traders, and processors.[1] We use this primary data on smallholder production in Mon State to estimate stallholder production costs and the profitability of smallholder rubber production across alternative yield and price scenarios. [2]

The plan for the paper is as follows. Section 2 provides an overview of Myanmar's rubber sector, including a brief history of rubber production, an overview of production levels, yields, and planted area, an introduction to Myanmar rubber producers, and a summary of rubber trade. Section 3 describes rubber production, processing, and marketing in Mon State as well as highlights potential interventions or policies for improved rubber sector governance. Lastly, in section 4 the profitability of current and future rubber investments is analyzed under a range of plausible price and wage scenarios, in order to identify priorities for the sector.

[1] These interviews were conducted in April and May 2016.

[2] Similar analyses of the economic potential of smallholder rubber production has been done for Thailand, (Besson, 2002) (Simien, 2005) (Delarue, 2011) Indonesia, (Jayasuriya & Barlow, 1984) and Laos (Manivong V, 2007) (Manivong & Cramb, 2008) (Thongmanivong, Yayoi, Phanvilay, & Vongvisouk, 2009) (Baird, 2009) . There are no recent studies of the profitability of rubber sector in Myanmar based on primary data.

2. OVERVIEW OF MYANMAR'S RUBBER SECTOR

History of Rubber Production in Myanmar

Although rubber (*Hevea brasiliensis*) was introduced to Myanmar by the British as early as 1876, it took nearly two decades for rubber production in Myanmar to take off. Compared with neighboring countries, climate conditions were less favorable in Myanmar and land markets as well as transport infrastructure were less developed (Keong, 1973). In addition to these limitations, smallholders were unsure of the economic value of rubber and therefore hesitated to join the sector. Further, the Myanmar government was unsuccessful in its attempt to develop a large-scale rubber plantation.

In the early 1900s, rubber farming finally began to take hold within European communities. Despite a steep increase in planted area from 1910 to 1920 from 10 thousand to 43 thousand hectares, economic conditions in the 1930s followed by the Japanese occupation in the early 1940s, and local political conditions in the latter half of the decade, slowed further expansion (Keong, 1973). In the 1950s, private rubber production resumed and expanded from 56.6 thousand hectares in 1960 to 89.1 thousand acres in 1969 (Burger & Smit, 1997). In the following decade, however, production slowed again as many rubber estates were nationalized. From 1963 to 1988 the government controlled the rubber sector through direct ownership of the majority of production with government estates, procurement of rubber as sole legal buyer, marketing of rubber both for export and national consumption, and the distribution of rubber imports (National Export Strategy of the Republic of the Union of Myanmar 2015-2019, 2015).

In 1989, the production of rubber was partially liberalized from state control. The government still retained control over rubber exports, but allowed for domestic producers to sell at will to local buyers for a two-year period, after which they had to sell 45 percent of their production to the government (Woods, 2012). The sector was completely liberalized in 2004 and planted acres more than tripled thereafter, from 203.2 thousand hectares in 2004 to 641.1 thousand hectares in 2014-15 (Figure 1) (Myanmar Rubber Planters and Producers Association, 2015).

Rubber Production and Yields

Myanmar is the ninth largest producer of rubber in the world (Table 1). Despite its position as the ninth largest producer, compared with its neighbors, rubber production is low. Thailand produces twenty-six times more rubber than Myanmar, Indonesia produces twenty-one times more rubber, and Vietnam produces six times more rubber (FAOSTAT Production Data, 2015). Further, in India, China, and Malaysia production is more than four times as large as in Myanmar. This difference in rubber production is a result of Myanmar's smaller sown areas, smaller harvested areas, and much lower yields.

The Food and Agriculture Organization (FAO) and the Myanmar Ministry of Agriculture and Irrigation (MOAI) estimates place rubber yields in Myanmar at 726 kilograms per hectare and 690 kilograms per hectare, respectively (Figure 1).These estimates are also confirmed by the 2015, MSRHS estimate, which places yields in Mon at 654 kilograms per hectare, slightly lower than the other two assessments. Regardless of the source, Myanmar has

the third lowest yields of the fifteen largest rubber producing countries. Thailand and Vietnam's yields are more than double Myanmar's yield levels. Low-yields in Myanmar are likely not a result of the smallholder structure of the sector. In Thailand, Malaysia, India, and Indonesia rubber production is also based on smallholder farming and these countries still maintain much higher yields (Development Alternatives, 2007). Instead, low yields in Myanmar are a result of poor farming practices across the value chain as well as limited rubber sector governance.

Planted and Harvested Area

MOAI estimates that in 2015-16 total rubber planted area was 652,105 hectares and total harvested rubber area was 297,216 hectares. Further, total production was estimated at 227, 533 tons. There is a huge gap between sown area and harvested area. In the past decade, the percentage of trees tapped did not rise above fifty percent of total trees planted. In 2005-06, forty-eight percent of trees planted were tapped, in 2008-09 during the rubber price spike, only thirty-four percent of trees planted were tapped, in 2015-16, as a result of the steady rubber price drop, forty-six percent of rubber trees planted were tapped (Ministry of Agriculture and Irrigation, 2010). Although we cannot be sure that this difference between planted and harvested area comes from new rubber plantations and not mature non-tapped trees, data from the MSRHS indicate that this area is mainly new production. For example, our survey found that among smallholders in Mon, forty-four percent of producers had no mature trees at all. Additionally, thirty-two percent of rubber farm owners in Mon acquired their plots after 2008 (Mon State Livelihoods and Rural Development Report, 2016). Overall, the low percentage of trees in production implies that the rubber sector will continue to expand, which puts additional importance on setting government priortities for rubber.

Historically, rubber was produced only in the south of Myanmar. Although the south continues to account for the majority of production, planting has increased in northern and central regions. In 2014-15 the three southern states and divisions, Mon, Tanintharyi and Kayin accounted for sixty-eight percent of sown rubber area and eighty-seven percent of harvest rubber area (Figure 2). Shan, Bago, and Kachin accounted for twenty-four percent of rubber sown area, but only ten percent of production.

In the past decade, rubber planting has increased across Myanmar. Rubber production expanded the fastest in Ayeyarwady Division, where sown area increased from only .4 thousand hectares in 2004-05 to 13.6 thousand hectares in 2014-15, an increase of 97 percent. Kachin and Shan state experienced similar levels of growth from 1.2 and 4.0 thousand hecatres to 31.0 and 74.2 thousand hectares respectively (Ministry of Agriculture and Irrigation, 2010). Further, in historic rubber production areas, although growth was slower comparatively, sown area still doubled over the same period. In all regions, the price spike from 2006 to 2008 drove rubber expansion, with the greatest extensions during the period taking place in Shan, Kachin, and Ayeyarwady.

Rubber Producers

Prior to policy changes in the early 1990s, the government had a substantially greater involvement in the rubber sector. In 1988-99 the state owned 9.6 percent of the total planted area and 16.2 percent of total production. By 2006-07 the government had already decreased its landholdings to 5.8 and production to 5.9 percent respectively, and by 2010-11 the Myanmar government controlled less than 3 percent of planted area and total production (Myint, 2013).

Rubber farmers in Myanmar are predominately smallholders. Unfortunately, there is limited recent data that disaggregates rubber production by size of plot. An MOAI table from 2005-06, shows that 40.2 percent of rubber producers were smallholders with less than 2.02 hectares in that year, 50.3 percent were medium holders with between 2.0 and 8.1 hectares, and 9.5 percent were large plantation owners, with more than 8.1 sown hectares . In the same year, large holders produced 58.1 percent of output, medium holders, 33.3 and smallholders 8.6 percent (Myint, 2013). The literature indicates that today, large holders own a greater amount of rubber land (Kenney-Lazar, 2016) (What Future for the Rubber Industry in Myanmar?, 2014) (Woods, 2012). This is mainly a result of a new policy preference to give concessions to large holders to bring about big increases in production and meet agriculture production targets (Woods, 2012). Rubber expansion in the south is due to increased smallholder production, whereas rubber expansion in the north is mainly a result of increased large holder production.

Estimates based on data from the 2015, MSRHS indicate that smallholders and medium holders have a combined 126,370 hectares of rubber land in Mon State, equivalent to 63 percent of the total MOAI estimate for sown acres in Mon in in that year. Using the latest MOAI estimate for Government ownership of rubber land, 2.3 percent, we find that 34.7 percent of plantation owners in Mon own more than 8.09 hectares, a considerable increase from 2005-06 data.

Trade

Since there is almost no downstream rubber market in Myanmar almost all rubber is exported. Rubber exports have increased significantly over the past decade, but have leveled out in recent years (Figure 3). After reaching 92.7 thousand tons in 2010, exports have declined slightly, averaging 81.8 tons over the following five years. Myanmar export data shows a sharp increase in export value from 2008 to 2011, followed by a strong decline. Myanmar import data from other countries mirrors export data but does not show as sharp an increase or decrease. Further, despite the value decrease in recent years resulting from the rubber price drop, export value is still much greater than ten years ago as a result of increases in export quantity.

Myanmar currently exports rubber to Asia and Europe. Myanmar's rubber export destinations are very concentrated, with three countries, China, Malaysia, and India, importing nearly all of Myanmar's rubber. Using Myanmar import data from importer countries, we see a sharp increase in the importance of China as a rubber trading partner for Myanmar (Table 3). In 2005, China imported just 21.4 percent of Myanmar's rubber. Malaysia was by far Myanmar's largest trading partner importing 67.0 percent of rubber. India was Myanmar's third largest trading partner and imported 7.4 percent of the country's rubber (Table 3). In 2014, China imported 72.7 percent of Myanmar's rubber, Malaysia, 20.3 percent and South Korea 3.4 percent

(Comtrade Data, 2016). It is possible that China was already a much more important trading partner in 2005 than the numbers show, depending on the amount of non-recorded across border exports. Myanmar exports mainly low quality sheet rubber. China imports almost all grades of Myanmar's block and sheet rubber. Malaysia imports inferior grades of Myanmar's block and sheet rubber to process into value added higher grades for tire production or re-export. The Republic of Korea imports higher grade Myanmar sheet rubber for tire production (National Export Strategy of the Republic of the Union of Myanmar 2015-2019, 2015).[3] Myanmar has struggled to tap into new markets such as the United States, Japan, Germany and India, all of which are major rubber importers.

In Myanmar, rubber exporters have to bear the cost of several cumulative taxes. The Ministry of Finance and Revenue levies an advance 2 percent tax for exporters. Further, a corporate tax of 25 percent is imposed on companies. Finally, rubber is the only agricultural commodity subjected to a commercial tax (5 percent) (National Export Strategy of the Republic of the Union of Myanmar 2015-2019, 2015). Additionally, exporters have other added charges such as a licensing fee for membership to MRPPA.

[3] Please refer to the National Export Strategty of the Republic of the Union of Myanmar for a detailed analyis of exports.

3. RUBBER PRODUCTION, PROCESSING AND MARKETING IN MON STATE

Production Area

Rubber production in Myanmar is centered in Mon state. In 2014-15, 31 percent of the rubber sown and 49 percent of the rubber harvested was in Mon state. Mon State is located in the south of Myanmar, bordered by Bago Region to the North, Kayin to the East, and Tanintharyi to the South. It also shares a short South-Eastern border with Thailand. Mon is among the smaller states of Myanmar, but with a population of 2 million inhabitants it is relatively densely populated. Its proximity to Yangon and Thailand contribute to its economic importance.

According to the MSRHS, 19 percent of households in Mon own rubber farms, making the sector just as large as the state's rice sector. Of the rubber farms surveyed in the MSRHS, 19 percent were in Thaton, the district bordering Yangon Region, and 71 percent were in Mawlamyine District, which borders Thailand and Tanintharyi. The central part of the state has the greatest concentration of rubber farms (in the townships of Kyaikmaraw, Mudon and Thanbyuzat). This is also where the largest rubber farms are found, averaging 7 hectares in Thanbyuzat. Forty-six percent of rubber farms are located in upland areas, 35 percent in lowland areas, and 19 percent on coastal land. This is in contrast with rice, where only 26 percent of producers were in the upland region, while 57 percent were in the lowland region.

Like in other states, rubber plantations in Mon are increasing in terms of acreage and economic contribution to the State. According to the Myanmar Ministry of Agriculture (MoAI), planted area in Mon has increased 8 percent annually, from 53.4 thousand hectares in 1997-98 to 197.9 thousand hectares in 2014-15. Rubber expansion is primarily occurring in upland areas in Mawlamyine District, though rubber producers have expanded in all townships and all geographic zones.

Rubber Producers

The majority of Mon state rubber farmers are smallholders, owning less than 2 hectares. The average Mon state rubber plantation size is 2.2 hectares, while the median plot size is 1.6 hectares. Rubber smallholders, for the most part, establish their plantations in their hometowns, and work on their rubber farms with their families. In Mon State, eighty-two percent of rubber farms were built where the household head was born (Mon State Livelihoods and Rural Development Report, 2016). Rubber is often the sole agricultural income of rubber producing households. While rubber revenues contributed forty-five percent of household income, other crops added six percent, and non-farm income made up the remaining forty-nine percent (Mon State Livelihoods and Rural Development Report, 2016). Rubber farmers rely mainly on family labor for production. In Mon, eighty-four percent of rubber producing household heads work on their own rubber farms (Mon State Livelihoods and Rural Development Report, 2016). Depending on the amount of family labor the plantation has access to, the smallholder will hire outside workers to tap trees, clear weeds from the base of the rubber trees, or apply fertilizer.

Rubber and rice farming are the principle sources of agriculture income in Mon. When comparing rubber farming households with rice farming households, and other rural households

in Mon, we observe important differences between the families. Rubber farming households are more remote than both rice farming households, and other rural households (Table 4). Only 35 percent of rubber farmers have access to electricity, while 47 percent of rice farmers have electricity access, and 54 percent of other rural households have electricity access. Further, rubber households are located further from the coast, and predominately in upland areas (Table 4). Rubber farmers, despite their more remote locality, are not at an economic disadvantage. Per capita expenditure is actually higher among rubbing producing households than all other rural households. Further, rubber households have much higher ownership of land transportation vehicles than all other groups, 74 percent compared with 46 percent. Moreover, while rubber household land ownership is roughly the same as rice producing households, 2.2 hectares versus 2.4 hectares, it is significantly higher than other rural households, .4 hectares. Finally, although rubber farmers, appear to be better off economically than rice farmers, they do not follow best practice farming techniques. Compared with rice produces, it is much less likely for rubber producers to use fertilizer, machinery, or hired labor in production.

Fifty-five percent of rubber farmers in Mon are smallholders, owning less than two acres. These smallholders have an average farm size of .9 hectares compared with medium and large holders who have an average holding of 4.3 hectares (Table 5). Compared with smallholders, medium and large scale rubber produces are slightly more educated, have larger household sizes and greater total expenditure. Medium and large holders are also more likely to have a use right document for their land, 84 percent have the document compared with only 71 percent of smallholders (Table 5). Medium and large holders have planted more of their total land to rubber, and have a greater percentage of mature trees. They are more likely to use fertilizer in production as well as hired labor. Further, they are more likely to process there rubber at their farm. Despite these practices, yield estimates from our survey show a lower per hectare kilogram yield for medium and large holders compared with smallholders. This, however, is probably misleading and is a result of smallholder farmers' overestimating the number of trees they have per hectare, 810, or underestimating total plot size.

Inputs

The main production inputs for rubber farming include land, planting materials, and fertilizers. Rubber plantations are typically planted on vacant, forest, or pasture land. In Mon, 36 percent of new rubber farms have been converted from vacant, forest, or pasture land. Further, plantations are generally planted on uphill areas (Mon State Livelihoods and Rural Development Report, 2016). Upland areas often lack irrigation systems, and therefore, rubber planters rely almost exclusively on rain-fed irrigation methods. Even in lowland and coastal areas, where wells and rivers are more common, rubber producers rely on rain as their sole source of irrigation for their rubber plantations.

Whereas in the early 1990s farmers planted around seventy different rubber varieties, in Myanmar today, almost ninety percent of farmers plant one variety. The MOAI, through the Department of Industrial Crops Development (DICD) develops, tests, and sells rubber varieties to farmers. Budget cuts in 2005 led to a reduction in the number of model farms and their acreage (Tun, Kennedy, & Nischan, 2015). In the 1990s, the Myanmar government identified a few improved varieties that would work well in Myanmar's climate, such as RRIM600 and

BBM24 (Charles & Aung, 2015). Their names were circulated through the DICD and the Myanmar Rubber Planters and Producers Association, MRPPA. Despite this small government push to improve planting material, little changed, as it was not accompanied by investment in nurseries or improvement to the nursery policy environment. Nurseries are still unregulated and unregistered and this would have to change if Myanmar were to try and expand rubber production.

Myanmar rubber farmers use credit from friends or family or sell off assets to establish their rubber plantations. They buy seedlings from dealers in their village or from nurseries in their township, or they graft or bud rubber from neighboring plantations. CARE Myanmar, in its study of rubber farmers in Mon, found that although smallholders knew that planting improved rubber varieties was important for future productivity, few could actually identify the recommended varieties for Mon State (Charles & Aung, 2015). In our focus groups we found that likewise, participants were unable to name the variety they planted, or name the different varieties they could access. Further, most decided which variety of rubber to buy based on price rather than quality.

On average 655 trees are planted per hectare, or at the fiftieth percentile, 577. This is very high compared with the recommended 420 to 445 rubber trees per hectare. Rubber plantations are generally not intercropped. Plantation owners are unfamiliar with the appropriate planting distances for rubber trees (Charles & Aung, 2015). Further, plantation owners are unfamiliar with what other plants could be planted with rubber. Intercropping with other crops could add to the productivity and profitability of a newly developed rubber industry and could, perhaps, help defray some of the costs in the upgrading of rubber production.

Land preparation is done through slash and burn or slash and clear techniques. Rubber plantation owners or hired labor plant the rubber seedlings. The owners and or their workers are unfamiliar with the size of the hole needed for rubber planting (Charles & Aung, 2015). Minimal care is given to the rubber plantation during the first five to seven years of growth. Initial investments must be made, during this period, in tapping and collecting materials, such as knives, buckets, pans, and rubber sheet rollers.

Smallholders underuse fertilizer. Only sixty-five percent of rubber smallholder farmers in Myanmar used organic or chemical fertilizer in the past year. For the farmers that did use fertilizer, on average 1.8 bags of fertilizer were used per acre (Mon State Livelihoods and Rural Development Report, 2016). They were applied at the end of the rainy season. Producers understood that they were underusing fertilizer, but because of the low price of rubber, did not want to invest the extra money to apply the recommended amounts. Rubber farmers were slightly more familiar with which fertilizer type to use, compared with farmers in other sectors, but, nonetheless, their knowledge was rudimentary and mainly based on fertilizer bags that were labelled with the word rubber.

Rubber smallholders rely heavily on family labor for maintaining their land. Families, whose labor supply migrated to Thailand used outside labor. Daily wages paid to rubber workers were around 5,000 kyat per day. Limiting fertilizer use and relying on family labor allows smallholders to cut costs. Training in the varieties of rubber available for planting, in planting techniques and in the benefits of intercropping with other crops, as well as in the appropriate use of fertilizer would boost the production and the quality of rubber planted by smallholders.

Tapping and Collection

Rubber tapping and collection is an especially weak link in the rubber value chain. Rubber tapping is either carried out by a family member working on the farm or by outside labor. Rubber tappers are generally paid 10 kyat per tree tapped. Smallholders tap their trees every day or every two days with knives and buckets. Rubber is tapped year-round excluding the harshest months of the rainy season. Almost no one follows best practices and taps every other day. Care Myanmar, in its survey, likewise found that only four to nine percent of producers tap every other day. Tappers have not been trained in appropriate tapping practices. In Mon, more than seventy percent of farmers had no knowledge of the girth or the height of the tree required to start tapping. Further, seventy percent of farmers were also clueless as to the ideal angle to make initial incisions for tapping (Charles & Aung, 2015). Finally, smallholders did not know where and how much of the plant to tap. Poor tapping practices lead to life loss for rubber trees. Therefore government investment in areas such as improved varieties of rubber and marketing and certification schemes are of no value to smallholders if they do not learn how to improve their tapping practices.

After the rubber trees are tapped, the majority of smallholders process their rubber into sheets that they dry by hanging or on the ground near their plantation. In Myanmar, it is very rare for smallholders to sell non-sheeted latex. The equipment used in most Myanmar farms for tapping, -latex cups, collecting bins, grinding machines, - is dirty (Phyu, 2016). After the rubber is tapped, it is often mixed in containers with leaf or dirt debris. The rubber is then mixed with acid and water to coagulate. Water is over supplemented and non-recommended acids are used to avoid paying high prices for the appropriate acids. After the rubber is sheeted it is dried in the sand or dirt, further absorbing debris. The sheets are then sold to traders for smoking. Although rubber sheets can be stored indefinitely, producers prefer to sell their sheets immediately. Traders will further contaminate the rubber by mixing in used rubber from other sources. There are limited incentives for smallholders to keep rubber processing clean as the current price differential between different qualities of rubber is small. All of these issues need to be addressed in some way, either by the government or through donors, in order to up the quality and even viability of rubber production in Myanmar.

Yields

As demonstrated above, overall yield estimates for Myanmar vary depending on the source but range from 689 kilograms per hectare (MOAI estimate) to 726 kilograms per hectare (FAO estimate). The MOAI estimates are slightly greater than our survey estimates of 654 kilograms per hectare, which are median estimates calculated per tree (Table 2). All of the estimates place Myanmar yields lower than yields of other major rubber producing countries in the region with average yields ranging between 1,500 and 2,000 kilograms per hectare.

Yields in Myanmar vary across township. According to MOAI data for the 2014-15 year, Kayin State, Mon State and Ayeyarwady Division had the highest yields, at 855, 819 and 817 kilogram per hectare respectively. More recent rubber producing states, with far fewer plantations, such as Kachin, Shan, Saigaing, Yangon, and Rakhine have yields under 600, which is extremely low. Tanintharyi Division, which is one of the larger, more historic rubber producing regions, has very low yields of 621 (Ministry of Agriculture and Irrigation, 2010).

Differences in yields are a result of differences in rubber varieties used across Myanmar, as well as differences in production regimes. Further, the decision to tap or not tap is reflected in the rubber yield numbers, which reveals differences in labor costs across Myanmar, as well as in rubber prices.

Although yields are low, they are increasing. Yields have increased by 17 percent or a 2 percent growth rate over the ten year period from 2004-05 to 2014-15. This however, could simply be a result of overexploitation of trees to take advantage of high market prices or an increase in rubber production under large plantation. Patterns in Mon state demonstrate that indeed, this increase is probably not a result of improved production and tapping processes, or use of improved varieties.

Quality

As a result of poor planting techniques, cultivation management, tapping practices, field-level processing, and factory level processing, Myanmar rubber is of an extremely low quality. Traders interviewed in Mon felt that the quality of Myanmar's rubber raw material was among the best in the world, but the quality of Myanmar's processed rubber was the worst in the world.

There are limited incentives across the value chain for rubber actors to produce improved quality rubber. At the producer level, traders buy all rubber sheets regardless of quality. There is no formal grading system. Whereas rubber sheets are generally visually graded based on their characteristics, such as texture, color, and amount of resinous matter, in Myanmar grade is determined almost entirely by the thickness of the rubber sheet.[4] Therefore, prices are paid simply based on weight and not the true quality of the rubber. Traders also have limited incentives to improve the quality of the rubber they sell to processers. Processors buy all rubber from traders, even though almost always they have to reprocess it, because it is of poor quality. The traders' rubber is also graded by weight and not physical qualities. At the processor level, there is no certification scheme or public lab to test rubber quality. Therefore, processors will always receive a discounted price on the world market for their rubber as they cannot guarantee its quality.[5]

Rubber Processing

Rubber produced in Myanmar is mainly in the form of Ribbed Smoked Sheets (RSS) and Technically Specified (TSR) or Block Rubber. RSS rubber is made directly from latex, which is treated to coagulate, then air dried or smoked. TSR can be produced both from latex coagulum, known as cup-lump, and sheet rubber. TSR made up 40 percent of Myanmar's raw rubber exports in 2012, while RSS made up 60 percent (National Export Strategy of the Republic of the Union of Myanmar 2015-2019, 2015). Myanmar exports low-grade rubber of both types. Production of TSR rubber for export as opposed to RSS may be easier for Myanmar. Whereas

[4] In Myanmar weight is used as a proxy to measure rubber quality. The thicker the sheet, the more water or other particles the sheet has, the lower the quality of the sheet, the lower the price the producer will receive.
[5] Although Myanmar does sell different types of rubber (sheet and block) and different grades of rubber that receive different prices on the world market, they all face a discounted price within their grade because of the lack of certification scheme.

clean and uniform sheets are a requirement for the production of higher-grade RSS it is not for TSR. In order to upgrade RSS rubber, smallholders would have to deliver raw latex to factories to treat and dry their latex. This would be a burden for many smallholders, who would have to deliver their latex to distant factories every day. Another option for the production of high grade RSS rubber is for smallholders to invest in sheeting machinery for their farms, which would be extremely costly. On the other hand, TSR processing involves dewatering, dirt removal, re-drying and blending, and therefore farmers could continue to sell their sheeted latex of slightly poorer quality.

There are two state-run rubber processors and ten private processors in Myanmar (National Export Strategy of the Republic of the Union of Myanmar 2015-2019, 2015). The majority are located in and around Mudon. Two non-government processing companies established themselves in Mon before the 2004 liberalization of the sector. The remaining processing companies set up their facilities after 2010, following the increase in rubber output in the region and the government transition. In recent years, changing investment laws in Myanmar have permitted local companies to enter into joint ventures with foreign companies. So far, two joint ventures have been established with Thai rubber giants (Sri Trang Group Structure (Subsidiaries), 2016) (Alpha Commodities Pte. Ltd., 2013).

Processing factories in Myanmar produce mainly RSS rubber for export to China or Malaysia (National Export Strategy of the Republic of the Union of Myanmar 2015-2019, 2015). Since rubber production is still limited in Myanmar, compared to world demand, there has not yet been a time where supply has outpaced demand. The RSS produced in Myanmar by processors is of a lower quality than in neighboring countries, both because of the lower quality of the rubber sheet they buy from the smallholders and because of their processing technology. Processors buy all rubber from farmers, regardless of quality. Rubber quality control systems are lacking. Weight not quality determines the price of rubber, and therefore visual inspection of rubber to determine quality is non-existent.

At the factory level, the technologies used in processing rubber are often inadequate and outdated. Most importantly, infrastructure is limiting. Most processing plants do not have reliable electricity, and therefore have to rely on generators to produce electricity, which is costly and of questionable reliability. Although the Ministry of Industry issues licenses for rubber factories to operate, there are no regulations regarding rubber production processes. Further, there are no standard operating procedures to control the quality of processed rubber. For example, TSR cannot be properly specified since there are no quality control laboratories.

Rubber Manufacturing

Myanmar rubber is mainly exported for use in tire manufacturing. Local industry plays a very small role in the rubber value chain. The Myanmar Times estimated that only eight percent of Myanmar's total rubber production is used in manufacturing in Myanmar (Htwe, Low-quality rubber holds back tyres, 2015). The processing of natural rubber is costly because it requires expensive inputs most of which must be imported. There are four tire factories in Myanmar, two are owned by the Ministry of Industry, one is owned by Myanmar Economic Cooperation, and one is private, the Yangon Tire Factory (National Export Strategy of the Republic of the Union of Myanmar 2015-2019, 2015). Other factories include those that weave rubber products and

those that manufacture traditional rubber sandals (Shalini, 2015). Rubber soles are one of the few value added rubber products that Myanmar exports. In 2013, Myanmar exported US $ 6.4 million worth of outer soles to the Republic of Korea and US $ 107.6 million to Japan. While, Myanmar rubber sole exports only accounted for 0.9 percent of Korea's imports, rubber sole imports accounted for 7.2 percent of Japan's (National Export Strategy of the Republic of the Union of Myanmar 2015-2019, 2015). This is clearly a market that could be further developed.

Marketing

Farmers sell their rubber sheets to traders. If their plot size is large enough the trader will travel to their plantation to buy the rubber. Sometimes, however, the farmer will go to the trader to sell their rubber. In this case, the farmer is responsible for paying for transport. Farmers will sell to the trader who can offer the most money, but this varies little between traders. Although processers claimed that farmers could sell directly to their factories in addition to traders, we found no instances of this in our fieldwork.

There are three levels of rubber traders in Myanmar's rubber value chain. Since, Mudon is the center of rubber trading in Myanmar, a smallholder's distance to Mudon City determines the number of traders their rubber will pass through before arriving at a processor. Traders who collect rubber from rural villages are first level rubber traders. They are often rubber farmers as well as traders. They sell the rubber they buy to second level traders, or those located in township city centers. These traders are usually just traders and not farmers. Further, many of them trade multiple commodities in addition to rubber, such as limes or betel nut. Rubber farmers located close to cities bring their rubber directly to these traders, skipping first level traders. Second level traders sell their rubber to third level traders, or traders located in Mudon City. These traders have smoking plants, where they process the rubber preliminarily before selling it to processing companies. They sell their rubber to the processing company in Mudon that can offer the highest price. In Mudon, there are around seventy rubber traders, fifty collecting from rural villages and twenty in Mudon city.

Traders finance producers and other collectors down the value chain as well as provide transport. Traders at all levels of the value chain claimed to earn between 10 and 20 kyats per pound of rubber. This implies that a rubber farmer located in a rural township and not in Mudon could receive as much as sixty kyats less for their rubber compared with the rubber export price.

Myanmar rubber prices are set by the processing factories. The processing companies set prices based on international market prices, mainly from Malaysia and Singapore, as well as based on international demand. Rubber production in Myanmar has little to no effect on Myanmar rubber prices. Therefore, although in Myanmar's cold season there is a lot more rubber produced than in the hot season, this has no effect on price. Processors claim that there is never a shortage of demand so they will buy all rubber all year round.

The average price reported for rubber in Mon state in May 2015 was 567 Kyat per pound or US .97 cents per kilogram and the median was 500 (US 88 cents per kg). The lowest price reported was 350 kyat (US 60 cents per kg) and the highest was 2,500 kyat per pound (US

4.29 dollars per kg). The average price for thin sheets (736 kyat per pound) was higher than the average price for thick (475 kyat per pound). Upon return to the region nearly a year later prices had dropped to 400 kyat per pound or US. 69 cents per kilogram. As shown in Table 6, for the equivalent grade of TSR rubber, Myanmar sells its rubber for on average 65 percent of the price of its neighbors. Malaysia, which in January had the lowest rubber of the neighboring countries, still has a price 1.27 times greater than Myanmar's rubber price.

When comparing farm-gate prices with export prices we see that that the average farm-gate price is 83 percent of the export price for standard block rubber. Mon rubber producers face low farm-gate prices because of substandard marketing channels. In practice, most farmers, particularly smallholders want to liquidate their rubber as soon as possible and therefore sell regardless of market price. Furthermore, most rubber is sold either through two or three levels of traders, which reduces the price received by the farmers significantly.

There is no rubber marketing infrastructure currently in Myanmar. The Government has recognized the need for such infrastructure, and newspapers indicate that Myanmar's first central rubber market will be set up in Mawlamyine. Exporters will be able to buy rubber through an auction system at the market. Planters can refuse to sell if they are not happy with the bid (Htwe, Myanmar Times, 2015) . At the time of writing, however, there was no evidence that any such market was being erected, and producers across Mon State have not heard about this plan.

Policy support

Depending on the level of the value chain, the Myanmar rubber sector is managed by several different state actors. The forest department under the Ministry of Environmental Conservation and Forestry manages current and future land under rubber cultivation. MOAI manages land usage through their Settlement and Land Records Department. The MOAI also manages training and education and research and development in both upstream and downstream rubber industries. Inspection and industrial supervision, however, falls under the jurisdiction of the Ministry of Industry (MOI), under the directorate of industrial supervision and inspection. Further, the MOI issues business licenses, promotes small and medium size enterprises and manages the last of the state owned industry. The Ministry of Commerce (MOC) also provides important governance to the rubber industry as they manage trade policy, import and export licenses, border control and trade promotion. The Ministry of Science and Technology provides research on rubber products including polymers of rubber. Finally, the Ministry of Finance and Revenue (MOFR) through the Myanmar Foreign Trade Bank, the Myanmar Investment and Commercial Bank, and the Myanmar Economic Bank provides commercial banking and foreign exchange for the sector (National Export Strategy of the Republic of the Union of Myanmar 2015-2019, 2015).

Rubber extension programs are run by the Department of Agriculture (DOA) under the umbrella of the MOAI. In Mon, there is a DOA extension office in each township. While the DOA spoke of an extensive training program, smallholders claimed that they had not benefited from one. Only 2.7 percent of households in Mon met with a government extension agent in the last 12 months. Meetings with private extension agents were more prevalent (7.6 percent). The majority of these private extension agents worked for fertilizer or pesticide companies though

and only provided extension services along with the purchase of their agricultural inputs. Therefore, despite alleged extension infrastructure, few trainings are actually taking place.

The institutional capacity of these institutions is weak and there is little cooperation among different government organizations and private stakeholders. Therefore, despite the myriad government agencies who control aspects of rubber governance, there are actually a limited number of laws that govern that sector. There are almost no regulations related to the planting of rubber nurseries and the distribution of cultivars. A notification requiring the registration of all rubber nurseries was issued by MOAI in 1992, but was never actually implemented (National Export Strategy of the Republic of the Union of Myanmar 2015-2019, 2015). There are no laws governing rubber trading. Traders do not have to be registered, and therefore rubber quality control is nearly impossible. Processors do have to register with the Directorate of Industrial Supervision and Inspection under MoI. At the same time, however, this has very little impact on sector governance as there are no laws regulating process, type and quality of processed rubber. Finally, exporters are required to have permits from the Department of Commerce and Consumer Affairs under MoC. But similarly to processors, exporters face no regulations related to types and grades exported. There is no certification system for the quality of rubber exported. It will take immense focus and coordination of the government institutions that regulate rubber production in order to increase production, quality, and production income.

Potential Interventions and Policy Options

Rubber Production

Markets for rubber inputs- land, planting material, fertilizer, acid- are weak. Prohibitive regulations regarding land use seriously hinder the development of the sector, as they are a major obstacle to the expansion of smallholder production. These regulations must be reformed, in order to allow smallholders to purchase new rubber plantations or expand their current production sites. Regulations should be passed to control nursery operations such as import and distribution of cultivars. Cultivars should be tested locally, prior to distribution among producers. Finally, input regulations should be strengthened, to ensure the importation of safe inputs only.

How rubber trees are planted and maintained throughout their lifetime affects rubber yields. Rubber farmers in Mon are not familiar with best practices either in planting or plantation upkeep. Education programs and trainings are necessary to raise awareness of best practices for purchasing planting material, planting rubber, using fertilizer, tapping and collection. Smallholders will also need to be trained in field-level processing. Smallholders should be made aware of the different processing inputs available and their uses. Extension, either through the government solely, or through the government in partnership with universities, agronomists and other experts, local companies, or donors is essential to improving cultivation management. Currently, the Strengthening Competiveness of Smallholder Rubber Farmers project is being implemented by CARE with the goal of improving smallholder rubber production.

Promoting diversification will help defray the costs of rubber investments and therefore improve rubber smallholder income. Combining livestock husbandry with rubber production is also another way to improve smallholder income. Rarely are rubber plantations inter-cropped

when rubber trees are young. Farmers are unaware of other crops that would thrive in rubber production areas and are scared of the effect that other plants would have on their rubber tree. Therefore, trainings in inert-cropping is also necessary to improve rubber smallholder well-being.

Loan programs should be targeted to rubber producers to help them obtain funds for planting, replanting, inter-cropping and fertilizer. Smallholders could also use loans or subsidies from township-wide rubber associations who fund inputs from shareholder money (this model already exists in Mon and could be further encouraged through government support). For example, Mon rubber producers are largely familiar with recommended rubber fertilizer types and application amounts. Despite this, rarely do smallholder rubber producers apply the recommended fertilizer amount. In fact, fertilizer is often the first input dropped by cash constrained smallholders, since rubber trees will produce with and without fertilizer. Access to formal financing will not only help producers afford materials, such as fertilizer, and technologies, but will also help them pay a higher price to workers for cleaner rubber processing.

A fund for replanting trees could promote transformation of the rubber sector. As a result of low prices, replanting seems to have stalled in Mon state. In recent years, as a result of low rubber prices, farmers have not been incentivized to replant their old or underperforming rubber trees. However, as rubber seedling prices are currently low (250 to 350 Kyat on average), it would be a perfect time for producers to replant. Encouraging continued replanting will help guarantee sufficient rubber production for export. The government should encourage replanting either through subsidizing rubber seedling prices or setting up an investment fund for replanting. The government could seek the support of a development bank or other development financial institutions actively looking to invest in Myanmar.

Rubber Processing, Grading and Certification

A rubber grading system as well as a standard payment method for graded rubber will be essential for growth in the rubber sector. Only by adopting these standards will Myanmar be able to improve the cleanliness and consistency of its rubber. Most rubber exporting countries have issued standards concerning technical specifications for block rubber. These standards have become recognizable brands on the world market. TSR in Thailand is known as STR (Standard Thai Rubber), in Indonesia as SIR (Standard Indonesia Rubber), and in Malaysia as MSR (Standard Malaysia Rubber). These labels comprise different grades, STR10 AND STR20, for example. Each grade is tested for dirt, ash, volatile matter, and nitrogen content as well as plasticity and color. Although some factories use the label of Myanmar Standard Rubber (MSR) 10 and 20, the quality of MSR10 or MSR20 varies significantly within the grade. Moreover, the quality of MSR20 is much below TSR20 and equivalents, and therefore Myanmar receives a discounted price for what appears to be the same grade.

Branding the MSR grading system and ensuring that products that receive the name MSR are of the correct quality are also required. In order to do this, Myanmar needs an appropriate pricing system for MSR rubber. Sheets, slabs, and clumps should not be purchased at farm-gate based on wet weight but instead by sheet thickness and visual qualities (i.e. visual contamination). Moreover, grading facilities must be introduced. Before the rubber is sold to the processor it should be graded. The processors should only market their rubber as MSR10 or

MSR20 if the sheets purchased to make the block are indeed of that grade. Only by adopting strict grading, marketing, and payment standards across the rubber value chain will the government be able to improve prices to producers and develop the rubber sector.

A rubber certification system is also necessary. Without a certification system, processors will receive lower prices and will not be able to access important rubber markets. The Government, through RTTCRP, is currently in charge of evaluating the quality of processed rubber. Tests are conducted on an irregular basis, however, and the RTTCRP laboratory is not accredited. This certification must be delivered by an independent third party according to international standards. Industrial standard series ISO 9000 emphasize quality control, which is required in the rubber manufacturing industry. Creating or inviting a body for ISO 9000 certification would be a first step in quality control management of raw rubber production in Myanmar. This would assist Myanmar in the promotion of its rubber products exports, as more and more buyers require the ISO 9000 standard for their exporters.

Sector Governance

Improving rubber sector governance is crucial. At present rubber processors do not have to be certified to export rubber. This means that even if processors are trying to use the MSR label, there is no way for quality to be assured, since processors cannot be held accountable. A rubber specific governance body should be set up, similar to the Malaysian Rubber Board or the Thai Rubber Association. The body should not only focus on the manufacture and marketing of rubber and rubber products but also on rubber production from cultivation to extraction. In this way the rubber sector could benefit from a coherent sector strategy and standard polices. Through this body, rubber processers could become certified. If creating a rubber specific body is not desired, than under the Ministry of Industry Myanmar should set up a governing body for the sector, to ensure that processors are certified and producing quality product.

4. PROFITABILITY OF RUBBER INVESTMENTS

Mon Rubber Production Structure and Costs

The sharp decline in international rubber prices relative to their peaks in 2011-12 has dramatically affected the profitability of rubber investments in Myanmar. In this section, we construct estimates of overall returns to investments in smallholder rubber, given changes in rubber prices, labor costs, and farming techniques. We use data from the MSRHS to determine Mon rubber farm structure and costs. We also make assumption of labor costs based on field interviews and focus groups.

Rubber farmers have three major costs: fertilizer, acid for processing latex, and labor. In Mon, farmers reported using 3.5 fertilizer bags (50 kg) per hectare per year, which is equivalent to 175 kg of fertilizer per hectare or 0.30 kilograms per tree per year (Table 7). This is well below a recommended 0.5 kilograms of fertilizer per tree (the general recommendation not specific to Mon soil and climate (Development Alternatives, 2007). Fertilizer prices ranged from 21,000 to 27,000 kyat per 50 kilogram bag, with a median price of 25,000 kyat per fifty kilogram bag. (In the MSRHS, prices differed based on quality and country of origin.) Sulfuric acid is the principle acid used in Mon state, and its median cost per hectare was 20,525 kyat (Table 7).

The final major cost of rubber production is labor. Rubber farmers detailed two different ways rubber workers could be paid; by daily rate or per tree tapped. In general, payments based on a daily rate was more common when plantations used permanent workers not only to tap and tend rubber trees but also to manage other crops. Smallholders more often pay on a per tree basis, however. On average Mon farmers pay 10 kyats per tree tapped. Farmers reported that they tap their trees for seven months, every two days with one day of rest. Using this assumption, and multiplying costs by the number of trees, we find that median tapping costs are 864,105 kyat per hectare or 432,052 kyat if we assume that the family only hired outside labor for half of the tapping work (Table 7).

For our base analysis, we use a median price of 1,102 kyat per kg, the median price reported in the MSRHS. Yields varied hugely between the median and the average. Those with higher average yields reported not only a larger number of trees per hectare 655 compared with 576, but also a higher output per tree, 1.61 kilograms compared with 1.13 kilograms (Table 2). Differences in yields resulted in huge differences in revenues for producers. Using median costs and profits and assuming no family labor, rubber farming revenue is negative. On the other hand, using average costs and profits, but keeping all other assumptions constant, revenue is positive. As median yields are much more in line with the reality on the ground (median MSRHS yields are similar to government and FAO yield estimates) we use these for our analysis. Finally, transportation costs are assumed to be zero since traders often purchase latex at the farm.

Mon Rubber Current Profitability Estimates

First, we evaluate current profitability based on current (2016) costs and prices. In these estimates, only producers with mature trees are considered and all initial investments are considered to be sunk costs. Using the base parameters presented above, we examined various price, labor, and planting scenarios. Currently, there are few smallholder farms that rely entirely

on hired labor for plantation management and tapping. We find if all else remains constant, in order for smallholders to break-even they need to use at least 28 percent family labor for tapping. A realistic estimate of the actual amount of family labor used in Mon is 50 percent. Using this assumption, but making no other changes to the model, we see revenues increase from -236,639 to 180,413 kyat per hectare or 292,042 kyat overall assuming a median plot size of 1.6 hectares. This is, however, only 18 percent of median income for rural Mon, (1,612,000 kyat). If family labor is not used yields would need to increase by 33 percent from 654 to 870 kilograms per hectare for producers to make a profit.

If world rubber price continues to fall or wage prices are driven up by increased migration to Thailand, the rubber production with the current technology is not sustainable. Using fifty percent family labor as the base model, if price decreases by 25 percent, producers just break-even; rubber production is no longer profitable. If prices continue to fall to 2002 price levels, (a price decline of 36 percent in real terms), rubber net income becomes negative. Likewise, rubber production would no longer be profitable if per tree harvesting costs rise from 10 kyat per tree to 15 kyat per tree, assuming 50 percent family labor.

Profitability of Mon rubber production practices could rise substantially if farmers adopted best practices --increasing fertilizer input from 0.3 to 0.5 kilograms per tree, using better quality acid (thereby increasing acid costs by 20 percent), and reducing the number of trees per hectare from 576 to 520. Labor costs would decrease, because trees are tapped every other day instead of every two or three days. Although, the amount of rubber produced shrinks due to fewer days of tapping, rubber yields increase to 825.5 kilograms per hectare, a 40 percent increase. Assuming 50 percent family labor, revenue increases to 741,820 kyat. Even if rubber price decrease to 2002 levels, revenue is still positive, 212,000 kyat, only slightly below current median revenue. A wage increase, likewise, drops revenue to a similar level, but allows for continued rubber production.

Mon Rubber Net Present Value Estimates

Second, we evaluate future profitability through a series of net present value (NPV) calculations. Base assumptions used in these NPV calculations are presented in Table 8. In these analyses we evaluate potential earnings for smallholders selling both RSS and TSR. We assume that farmers who sell their rubber to TSR factories produce the lowest quality rubber, and therefore face the lowest prices, but have slightly lower production costs. In our base analysis, producers sell RSS 5 and TSR 50, the most common grades sold in Myanmar and the lowest grades sold on the international market. Further, producers sell low quality RSS 5 and TSR 50, meaning that there is not only room for within grade quality improvement, but also for improving quality enough to upgrade grades. We run analyses for this low quality rubber, but also for improved quality grade 5 rubber and grade 3 rubber. We assume that these quality improvements are a result of improved producer collection, tapping, and sheeting practices from training and do not require greater smallholder investments or costs. It is important to note that even if quality improvements such of these are made, Myanmar smallholders will continue to receive a discounted price for their superior rubber unless grading and certification schemes are introduced. These analyses assume that these systems have been put in place.

Rubber production in Mon expanded significantly in the late 2000s as Myanmar farmers responded to the sharp increase in world rubber prices. We examine the investment incentives of these Mon smallholders by calculating the Net Present Values (NPVs) of their new rubber investments using the historical costs and prices that prevailed in the years of initial investments (Figure 6). We hold the price and costs in the year of planting constant over the twenty year life of the rubber trees (Figure 5). In 2009, when rubber prices first rose, the NPV of RSS rubber production was still very low, and the NPV for TSR rubber production was negative. This changed considerably with the rubber price increase of 2010 and 2011. Rubber investments became extremely profitable, rising to $7,500 for RSS and $6,800 for TSR. After 2013, when the price dropped back to pre-2009 levels, NPVs for both RSS and TSR became negative. Further, they became even more negative than NPVs in 2009, because of increasing labor costs. Thus far, in 2016 the prices have dropped below 2015 levels, and 2016 NPVS are the lowest for the entire period: -$1,800 and -$1,900 per smallholder farm, respectively.

Using 2015 rubber prices as our base price, and assuming rubber investments took place in 2009, we estimate NPVs for different qualities and grades of RSS and TSR rubber (Table 8). First, **if prices remain low, even if smallholders improve their rubber quality or grade, rubber production will not be profitable** (Table 8). And if wages were to increase while prices remained low, smallholders would face huge losses from their rubber plantations, even with quality and grade improvements (Table 8).

If world prices, however, were to return to the high 2009-15 price average, even if quality is not upgraded, rubber would be profitable (Table 8). If quality is also improved, rubber profitability would rise even further, with smallholder NPVs three times that of lower quality rubber. Moreover, if prices did improve, a wage rate increase would not be a major hindrance to rubber production, as both RSS and TSR NPVs would be positive, even without quality improvements (Table 8).

Figure 7 highlights the effects of changes in wage rates on the profitability of rubber production. Whereas real annual income payments from RSS and TSR production are always positive, albeit small at current wage rates, real wage increases of 10 percent per year make real income payments negative. For TSR income payments become negative after 5 years and for RSS incomes become negative after 7 years.

Using the same base scenario as above, but looking at two different yield increase possibilities we analyze future profitability of rubber. We assume that yield increases result from improved rubber planting, and farming practices and do not require greater investments or costs for producers. First, we see that even with increased yields (30 percent), if prices remain low, and rubber quality is low, NPV is negative (Table 9). NPV becomes positive only if yields increase by 50 percent. If wages were to increase, however, even if yields increased by 50 percent, without increasing the quality of rubber, NPVs would be negative. This means that **if rubber prices do not recover, Myanmar must act to improve both quality and yields**; just improving one will not help smallholders have a positive return on their rubber investments.

Finally, we analyze the profitability of investing in higher grade rubber such as RSS 1 and TSR 5. Whereas for smallholders, producing grade 1 RSS rubber requires a large initial investments in materials to produce clean sheet rubber, this is unnecessary for the production of TSR. Instead, for TSR the required new investments take place at the factory level. Additionally,

in order to produce high quality RSS rubber, smallholders will need to pay higher wages to workers, since they need to tap the rubber carefully, mix the rubber for a longer time, and sheet it judiciously. This labor cost increase will be smaller for TSR producers, as TSR smallholder rubber does not need to be as clean. At current rubber prices, farmer investment to produce RSS Grade 1 would not be profitable: these NPV would be US$-1,547/-7 (Figure 8). Although with higher world prices this investment in processing at the farm level would generate substantial revenue to producers, an increase in yields would bring about the same increase in revenue at a much smaller cost. Investment by processors to produce higher quality TSR as opposed to RSS would also benefit smallholders who would not need to make the initial risky investments involved with upgrading to labor-intensive RSS-1 processing.

5. CONCLUSION

Myanmar's rubber sector is at a critical juncture. Rubber production is projected to increase in the coming years as the trees planted during the rubber price spike mature. Despite this production increase, the country will still need to overcome several major problems in order to become a large rubber exporter. Further, if some of these weaknesses are not addressed, the rubber sector will not only fail to grow, but may actually collapse. Over the past five years rubber prices have dropped substantially, making tapping of rubber too expensive for many smallholders. If rubber prices continue to fall, or wages increase, smallholder rubber production will no longer be sustainable. Rubber prices, however, are projected to increase steadily. However, in order for Myanmar to take advantage of this improved global rubber climate, major changes are needed.

The biggest challenges facing Myanmar's smallholders are low rubber productivity, poor rubber quality, and lack of rubber policy support. Smallholders plant low-yielding rubber varieties as a result of poor nursery regulation, lack of research and limited training of extension workers and farmers. Further, poor farming, tapping and processing techniques result in low yielding, low quality rubber. Smallholders are untrained in critical areas and there has been little improvement in tapping and processing techniques over the past decade. Myanmar lacks quality standards and certification processes for rubber processers; therefore, farmers and processors receive discounted prices for their rubber. Lastly, there is no integrated rubber strategy on the part of the government so the sector is largely ungoverned and producers receive little or no support in terms of technology, training or marketing.

Using cost structures built from Mon smallholders primary data, we find that in the absence of major increase in world prices (substantially above the 2000-16 average), new rubber investments will not be profitable without major upgrades in yield, quality and price. Moreover, wage rates are likely to continue to rise as a result of limited labor surplus and increasing integration with the Thai labor market, further reducing the future profitability of the sector. Assuming prices do not improve, increasing only yields, only quality, or only improving the institutional environment will not result in positive returns on investment for smallholders. Investments and reforms are needed in all three areas. In addition, maintaining macro-stability and a competitive real exchange rate will be crucial to rubber sector profitably.

Thus, a concerted effort is needed on the part of public institutions, farmers and processors to improve, yields, quality, and sector governance. If this effort is made the sector may blossom into not only an important outlet of export earnings, but also a major source of employment and rural incomes in Mon State. If the sector's issues are not addressed, rubber production may instead cease to be a sustainable income source for rural smallholders.

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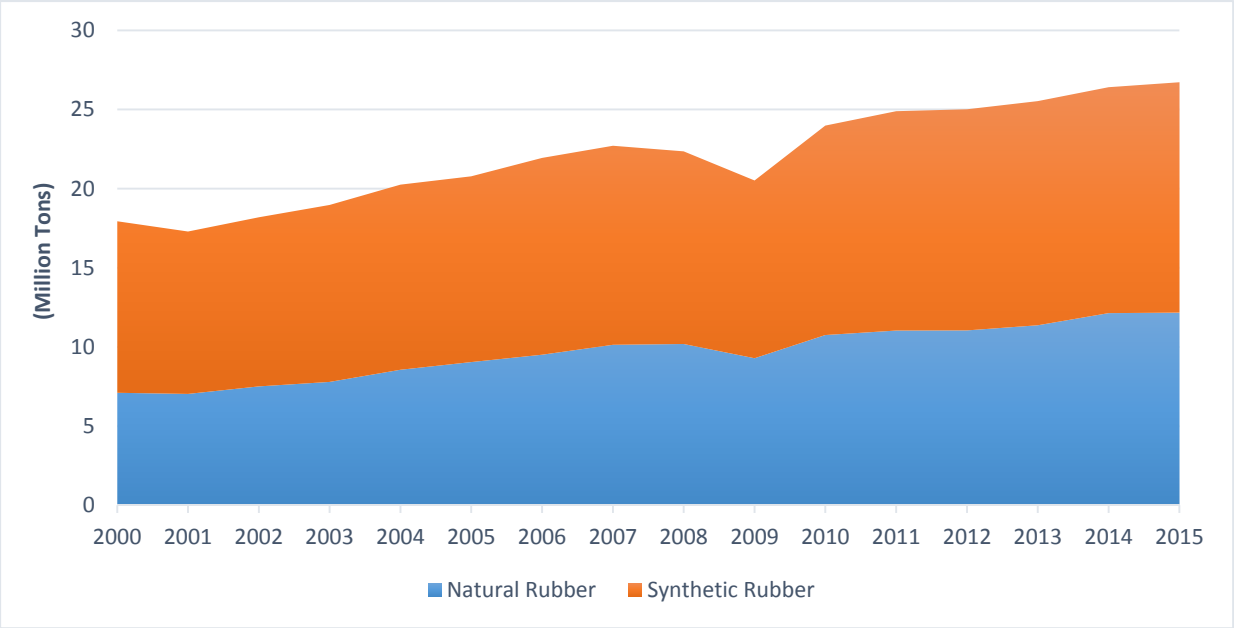
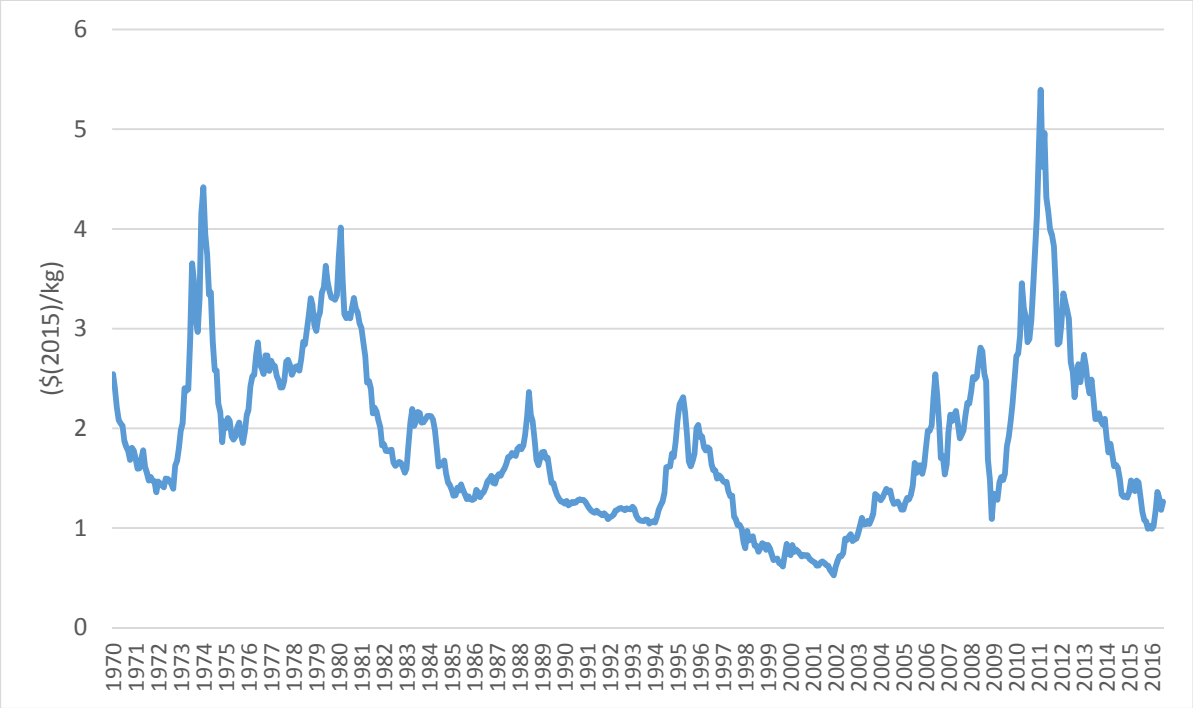
Figure 1—World Rubber Consumption



Source: Authors' calculations from Malaysian Rubber Board data.

Figure 2—World Rubber Prices



Source: World Bank Commodity Price Data
Note: Prices are shown for January. Prices are in real dollars deflated by US CPI (2005=1.0)

Table 1—World Rubber Production ('00,000 tons)

	1995	2004	2013	Percent Change (1995-2013)
Thailand	2,061	3,007	3,863	37%
Indonesia	1,532	2,066	3,108	42%
Vietnam	125	419	949	176%
India	472	750	900	38%
China	424	575	865	43%
Malaysia	1,089	1,169	826	-13%
Cote d'Ivoire	64	137	290	112%
Brazil	44	99	186	105%
Myanmar	27	39	148	132%
Nigeria	125	142	144	7%

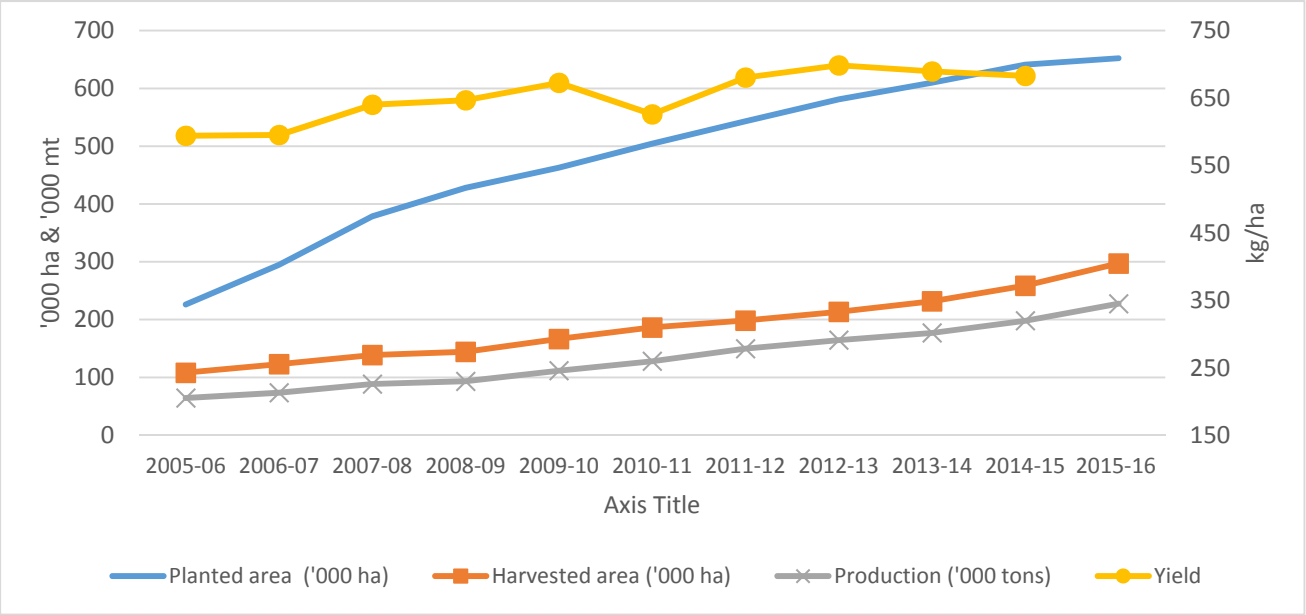
Source: Authors' calculations from FAOSTAT data

Table 2—World Rubber Yields (kg/ha)

	1995	2004	2013	Percent Change (1995-2013)
Côte d'Ivoire	1,400	1,593	2,145	24%
India	1,326	1,704	2,036	24%
Vietnam	849	1,393	1,732	43%
Thailand	1,378	1,816	1,596	8%
Brazil	550	929	1,327	55%
China	1,072	1,265	1,261	8%
Indonesia	678	772	874	14%
Malaysia	738	917	782	3%
Myanmar	526	542	726	17%
Nigeria	421	419	416	-1%

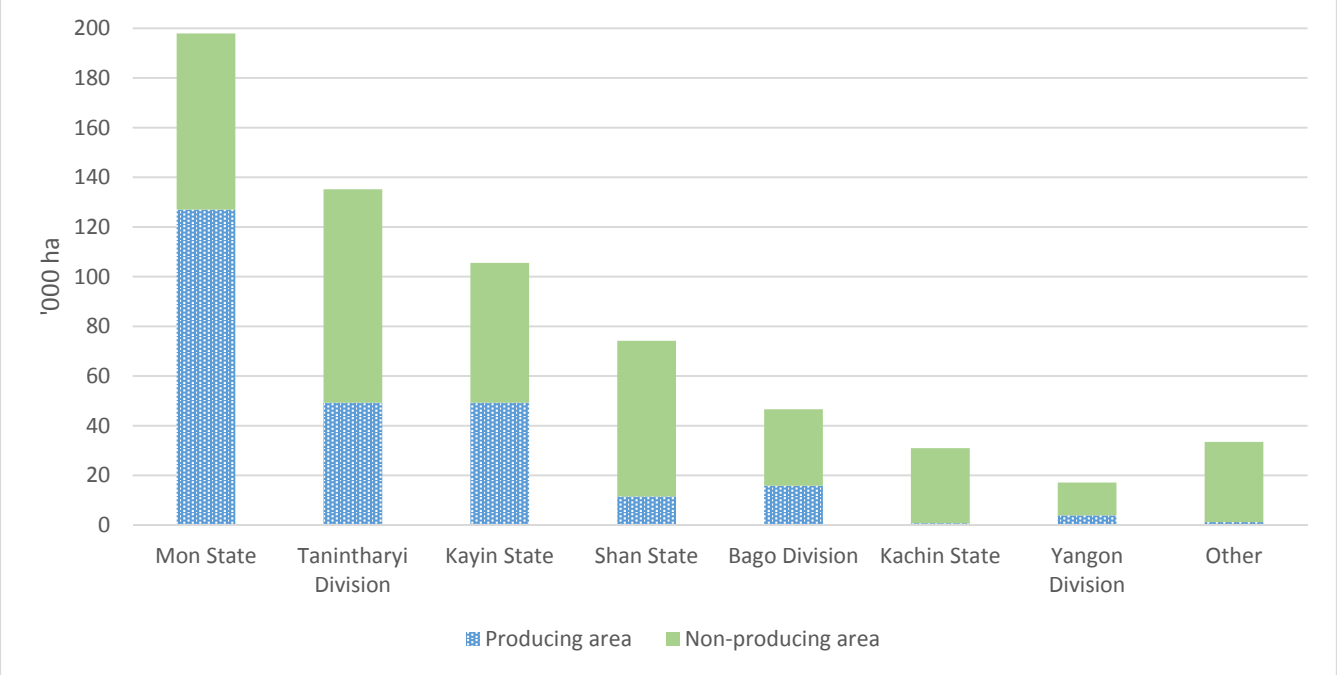
Source: Authors' calculations from FAOSTAT data

Figure 3—Myanmar Rubber Production Estimates



Source: Authors' calculations from MOAI data

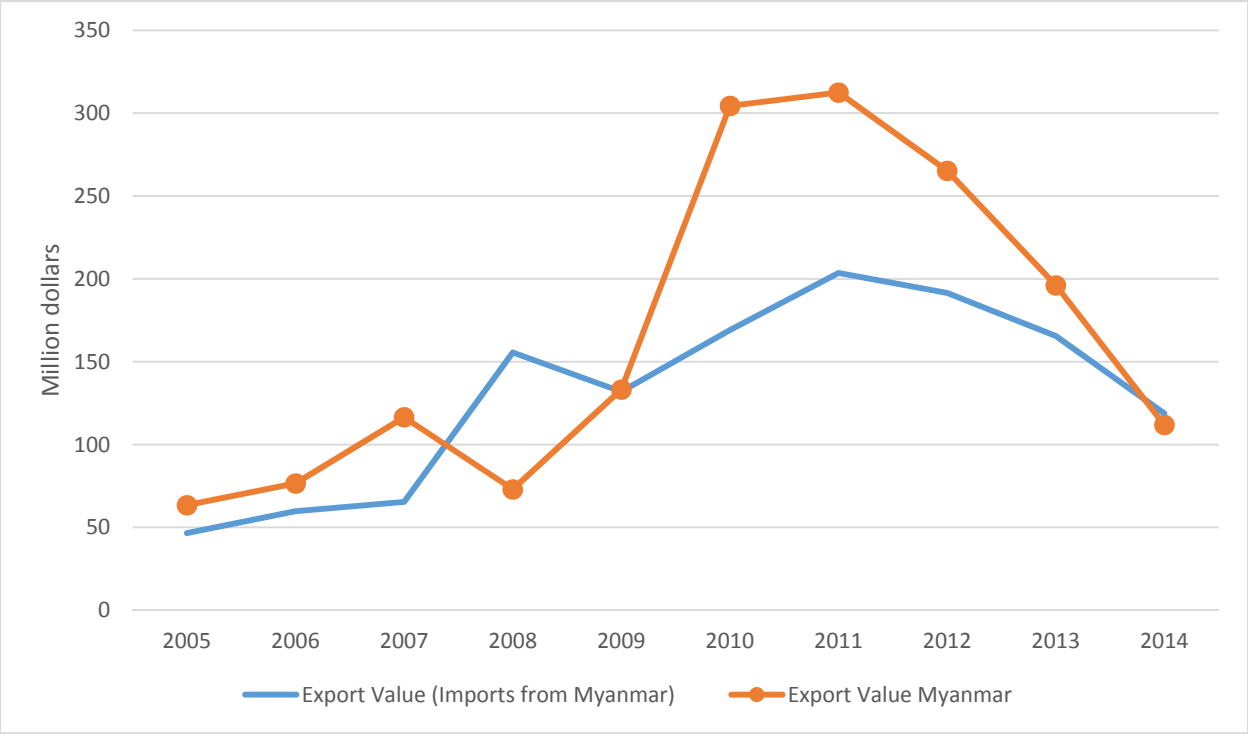
Figure 4—Myanmar total rubber producing and non-producing area



Source: Authors' calculations for MOAI data

Note: Producing area is land that is planted mature rubber trees that are producing rubber. Non-producing area is land that is planted to rubber, but the trees are not yet mature (non- producing) or are mature but are not being tapped.

Figure 5—Myanmar Rubber Exports



Source: Authors' calculations from UN COMTRADE and MOAI data

Table 3—Myanmar's Principle Rubber Export Partners

	China	Malaysia	South Korea	India
2014	73%	20%	3%	0%
2013	75%	20%	5%	0%
2012	63%	16%	8%	1%
2011	54%	35%	6%	2%
2010	43%	37%	4%	1%
2009	18%	72%	4%	0%
2008	37%	59%	0%	0%
2007	40%	50%	0%	2%
2006	36%	54%	0%	4%
2005	21%	67%	1%	7%

Source: Authors' calculations from UN Comtrade

Table 4—Characteristics of Mon Rural Households

	Rubber farmers	Rice farmers	Other rural hhs	All Rural Mon
Percent of households located in upland areas	49%	25%	38%	38%
Household distance to coast (km)	18	14	14	15
Percent of households with access to electricity	35%	47%	54%	49%
Per capita expenditure ('000 kyat)	551.3	481.3	512.5	512.3
Percent of Household heads without education	16%	22%	20%	19%
Percent of households with migrants	52%	54%	46%	49%
Household total land owned (ha)	2.2	2.4	0.4	1.0
Percent of households who own agriculture land	96%	87%	17%	43%
Percent of households who own motorized land vehicles	74%	60%	36%	46%
Percent of households who own agriculture machinery	9%	41%	1%	9%
Percent of households who use fertilizer in production	69%	88%	7%	32%
Percent of households who use machinery in production	36%	87%	5%	25%
Percent of households who use hired labor in production	42%	55%	4%	19%

Source: Authors' calculations from MSRHS.

Note: Only 1.5 percent of farmers earn income from cultivating both rubber and rice. These households were characterized by primary source of income.

Table 5—Characteristics of Mon Rural Rubber Producing Households by Farm Size

	Smallholder rubber (less than 2 hectares)	Medium and large holder rubber (greater than 2 hectares)	All rubber producers
Number of observations	182	145	327
Number of weighted observations	28,655	23,640	52,295
Household size	4.4	5.1	4.7
Years of education hh head	3.2	4.3	3.7
Age of hh head	52.1	54.5	53.2
Percent of hhs with use right document	71%	84%	77%
Percent of hhs with returned migrant	15%	10%	13%
Hh total expenditure ('000 kyat)	2,335.8	2,711.3	2,505.5
Average rubber farm size (ha)	0.9	4.3	2.2
Percent of total land owned planted to rubber	62%	82%	71%
Average number of rubber trees	673.7	2,168.9	2,168.9
Number of rubber trees (per ha)	810.6	534.5	686.0
Percent mature trees	34%	42%	38%
Percent of hhs who used acid to process the rubber	33%	57%	44%
Percent of hhs who used fertilizer	58%	71%	64%
Percent of hhs who used hired labor	32%	54%	42%
Number of buyers contacted	5.5	6.9	6.2
Total rubber produced (kg/year)	783.0	1861.3	1380.2
Average yield (kg/ha)	702.3	617.8	664.1

Source: Authors' calculations from MSRHS.

Table 6—Rubber Price by Grade and Type (January 2016)

Rubber Type	Myanmar Rubber Export Price ($/kg)	Thailand (RSS) / Malaysia(TSR) Export Price ($/kg))	Percent Difference
R.S.S (1)	1.00	1.32	76%
R.S.S (2)	0.95	1.30	73%
R.S.S (3)	0.90	1.27	71%
R.S.S (4)	0.85	1.28	66%
R.S.S (5)	0.80	1.27	63%
T.S.R (3)	1.15	1.59	72%
T.S.R (10)	0.90	1.56	58%
T.S.R (20)	0.85	1.56	55%

Source MRSSP, Thailand Rubber Board, Malaysia Rubber Board

Note: Percent difference refers to the percentage of the world price that Myanmar receives for each grade and type of rubber. This difference is mainly a result of differences in quality and lack of grading and certification scheme for rubber.

Table 7—Mon State Rubber Farm Costs and Production - Median 2015 RSS Estimates

Farm Structure		
Number of rubber trees (per ha)	577	
Yield (kg/per tree)	1.13	
Yield (kg/ha)	654	
Number of hectares per hh	1.62	
Cost Structure	**(kyat/ha)**	**(dollar/ha)**
Establishment costs	1,236,603	977
Seedling cost	450	0.4
Immature tree maintenance costs (per year)	107,722	85.1
Mature tree maintenance costs (per year)	540,299	427
Input costs (per year)	108,247	85.5
Fertilizer cost (50 kg bag urea)	25,000	19.8
Acid cost (ha/year)	20,525	16.2
Labor Cost Assumptions	**(kyat/ha)**	**(dollar/ha)**
Tapping wage (per tree)	10	0.01
Maintenance wage (per day)	5,000	4.0
Number of tree tapping days	145	-
Percent hired labor	50%	-
Labor costs	432,052	341.3
Total recurring costs per year	542,801	420.21

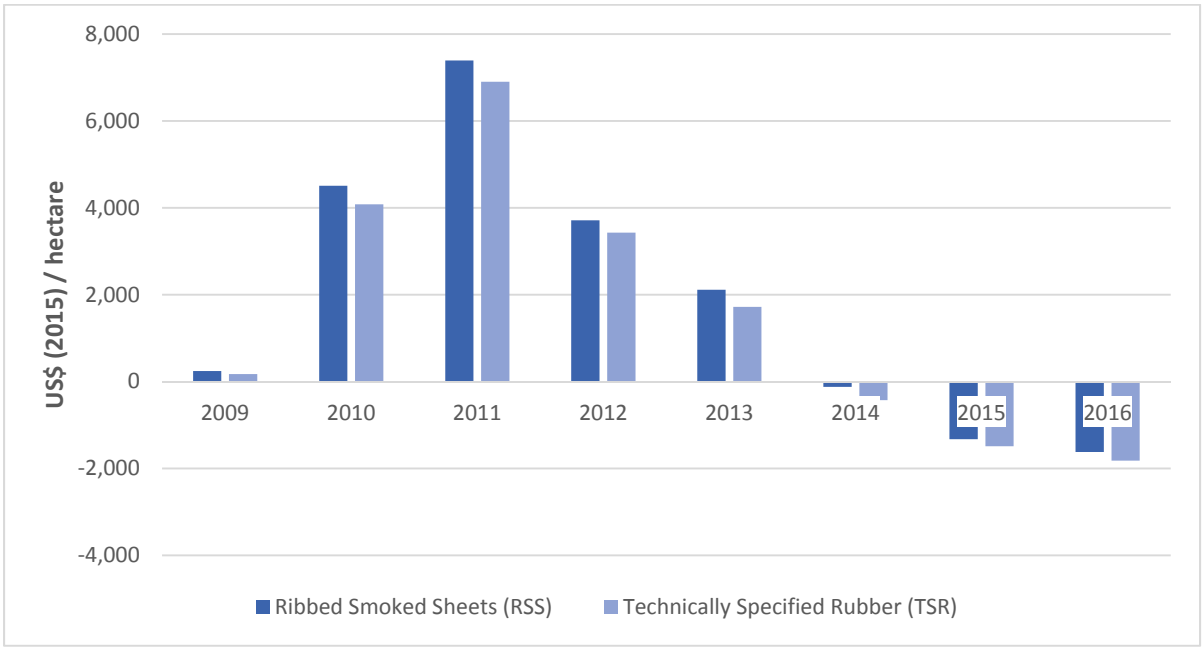
Source: Authors' calculations from Mon State Survey (2015).

Table 8: NPV Model Base Assumptions

	2015	2016-2029
Myanmar CPI	3.1	5% inflation per year
Myanmar Exchange Rate (Kyat/Dollar)	1,151	5% depreciation per year
Fertilizer Urea ($/mt)	25,713	4% increase per year
Wage Rate (Kyat/day)	5,000	5% increase per year
Wage Rate (Kyat/tree)	10	5% increase per year
Discount rate	10%	10%

Source: Model simulations.

Figure 1—Estimated Net Present Values of New Rubber Investments



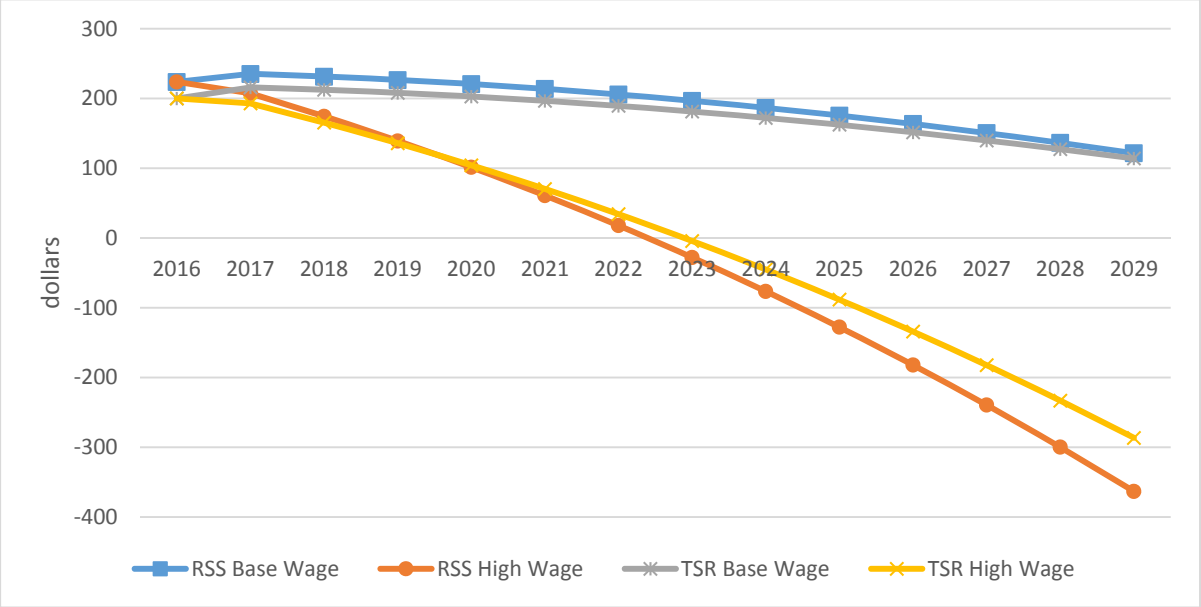
Source: Model simulations.

Table 9—Mon State, Rubber Production Net Present Value Estimates; Alternative Price and Wage Scenarios:

	RSS			TSR		
	RSS Grade 5		RSS Grade 3	TSR Grade 50		TSR Grade 20
Quality	Low	High	High	Low	High	High
Base world prices	-1,814	-399	-116	-1,895	-663	-417
High world prices	2,003	4,190	4,715	974	3,820	4,205
Increasing wages base prices	-2,438	-1,022	-739	-2,410	-1,179	-932
Increasing wages high prices	944	3,567	4,091	894	3,305	3,787

Source: Model simulations.

Figure 2—Estimated Annual Rubber Profits with Wage Rate Increases:



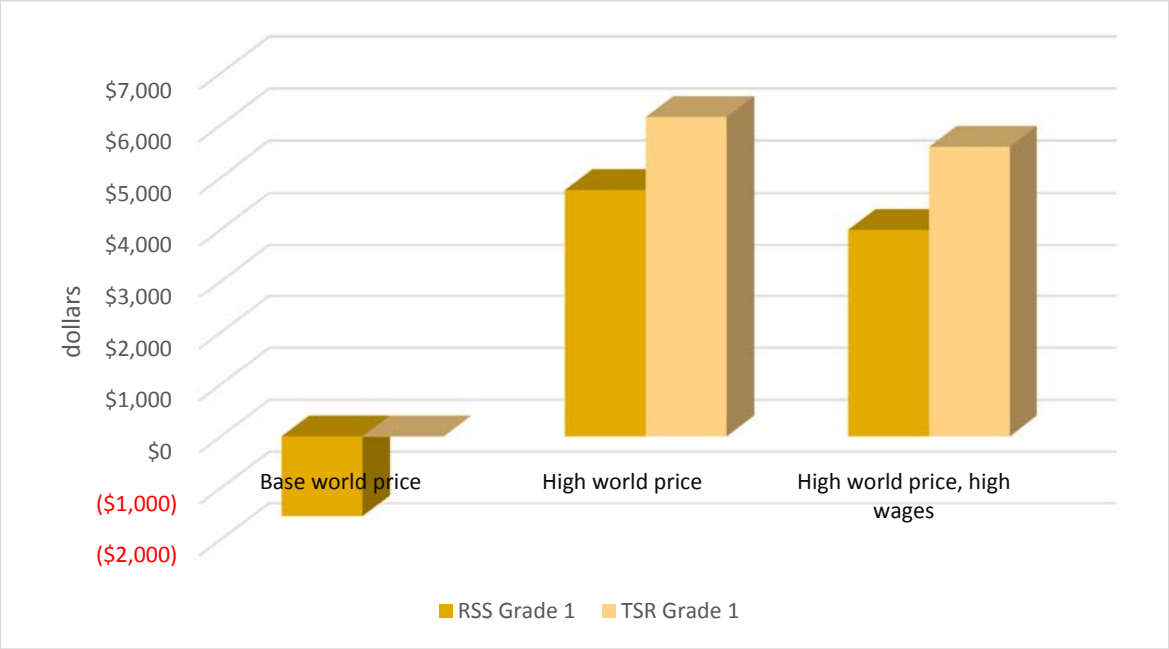
Source: Model simulations.

Table 10—Mon State, Rubber Production Net Present Value Estimates; Alternative Yield, Price and Wage Scenarios

	RSS Grade 5		TSR Grade 50	
	Low	High	Low	High
Base world prices (30% yield increase)	-626	1,214	-861	739
Base world prices (50% yield increase)	171	2,289	-171	1,676
High world prices (30% yield increase)	3,769	7,179	3,433	6,567
High world prices (50% yield increase)	5,240	9,174	4,785	8,401
Increasing wages, base prices (30% yield increase)	-1,249	590	-1,376	224
Increasing wages, base prices (50% yield increase)	-684	1,667	-980	1,161
Increasing wages, high prices (30% yield increase)	3,146	6,556	2,918	6,052
Increasing wages, high prices (50% yield increase)	4,616	8,551	4,270	7,886

Source: Model simulations.

Figure 3—Mon State, Rubber Production Net Present Value Estimates; Alternative Grade Scenarios



Source: Model simulations.