Value Chain Assessment:

Elephant Foot Yam Production In Southern Chin State

January 2017

Commissioned by MIID and authored by Jon Keesecker, Trevor Gibson, and Tluang Chin Sung.

MYANMAR INSTITUTE FOR INTEGRATED DEVELOPMENT
www.mmiid.org

Acknowledgements

The report authors would like to thank Duncan MacQueen, Marc Le Quentrec, and Derek Glass for sharing their research into elephant foot yam production in Myanmar.

This document has been produced for the Regional Community Forestry Training Center for Asia and the Pacific (RECOFTC) on behalf of the Myanmar Institute for Integrated Development (MIID) with funding from the Norwegian Ministry of Foreign Affairs. The views and opinions expressed in this report are those of the consultants and do not necessarily reflect those of RECOFTC, MIID, the Norwegian Ministry of Foreign Affairs or any other stakeholder.

MIID - Myanmar Institute for Integrated Development
12, Kanbawza Street
Yangon
Myanmar
Phone +95 1 545170
info@mmiid.org

Table of Contents

1. Executive Summary

1.1 Context and Background

In southern Chin state, trade in elephant foot yam (EFY) has increased dramatically over the past decade. As Chinese and Japanese food manufacturers have increasingly sourced Myanmar EFY for processed food manufacturing, the price of EFY has risen and Chin farmers have taken up cultivation of the tuber in large numbers. Today EFY is a major cash crop in this region of intense poverty, and uptake has approached 100% of households in villages where it is produced. Whereas farmers once foraged the tuber and sold it fresh, today most growers process and dry and chip EFY themselves in order to capture more value in the value chain. As a result, EFY production in Chin state has increased in recent years and village growers have experienced some livelihood improvement. Furthermore, growers remain enthusiastic about EFY production as a source of income and view increased cultivation as a pathway to economic improvement. Nonetheless, despite the benefits of EFY cultivation most growers in Chin state continue to suffer the effects of poverty and face continued economic insecurity.

1.2 Main Findings

EFY is the main cash crop for villagers in the study area and a critical source of household income, yet production inefficiencies continue to limit income from EFY. The primary opportunities to boost income from EFY production lie in increasing value in the value chain through product improvements, rather than capturing more of the value already existing within the value chain. Product improvements can impact growers supplying both the Chinese and the Japanese markets, although the Chinese market offers growers a greater return on labor. Most growers in the study area supply the Chinese market, which is estimated to account for 85% of all Myanmar EFY chips. The Chinese market also plays a larger role in setting prices for EFY chips, although in recent years prices have remained relatively stable at around 5000 Ky/viss. Nonetheless, growers are wise to be cautious in expanding EFY production, as future demand in both markets remains uncertain and Chin growers face competitive pressure from growers in China and other regions of Myanmar. Chin growers may have a competitive advantage insofar as their product is viewed as high quality and free of pesticides and fertilizers. However, other regions may have achieved greater production efficiencies, and Chin growers remain limited by household-level economic crises that undermine EFY production and expansion.

1.3 Recommendations

The study identified several short-term (1 year) and long-term (3-5 year) interventions for improving the income of EFY growers in southern Chin state. Short-term interventions and expected impact include:

- Provide slicers and drying materials to growers to improve EFY chip quality. In particular, drying systems that use fishnets or plastic solar houses should be trialed.
- Provide leguminous seed and natural mineral fertilizers (e.g. gypsum, rock phosphate) to growers to improve soil fertility and thereby boost year-to-year EFY yields.
- Provide scales to growers to ensure receipt of full product value at point of sale.
- Host farmer exposure tours to boost information sharing in the value chain, familiarize growers with buyer expectations, and demonstrate best practices for processing.
- Offer economic management skills to facilitate grower decision-making, particularly to improve retention of planting material for expanded cultivation.

The study also explored long-term interventions that focus more on asset-intensive investments in improving production and supply chain development. The first category includes support for the construction of local storage warehouses, processing facilities or seed banks, while the later may involve developing linkages with the Japanese supply chain and proving a domestic market for EFY-based processed foods. Continued policy support for community forestry models that enable expanding land available for cultivation may prove fruitful as a long-term intervention.

2. Research Background

2.1 Research Objectives

The core objectives of the study consisted of the following:

- Map EFY value chain, including products and factors of production (fertilizers, pesticides, etc.).
- Identify stakeholders involved in the EFY value chain and benefits received.
- Identify key constraints to effective and efficient EFY production.
- Determine market demand and production potential given the removal of production constraints.
- Forecast future demand for EFY, provided production reaches a given level of quality.
- Provide actionable recommendations in the form of project interventions that promote a more effective and efficient value chain and increase the social benefits to those in southern Chin state whose livelihoods depend upon EFY.

2.2 Research Methodology

This study is primarily qualitative and not designed to be statistically representative of populations. It employs direct observation from the field, village-level focus group discussions (FGDs), and key informant interviews (KIIs). Research was conducted during September - December 2016 and involved field visits to Mandalay, Yangon, Bangkok, and Chin state. All interviews but one were conducted in-person. Unless noted, values are stated in Myanmar kyat, and data is from direct sources. However, a number of studies proved extremely valuable.[1]

Table 1: Type, Number and Location of Respondents

Type	Location	Format	Sample Size
Grower	8 Villages	FGD	155
Town Trader	Mindat, Kampetlet	KII	6
Wholesaler	Mandalay, Pakokku	KII	8
Processor / Exporter	Yangon	KII	2
NGO	Yangon	KII	4
Trader Association	Yangon, Mindat, Bangkok	KII	3

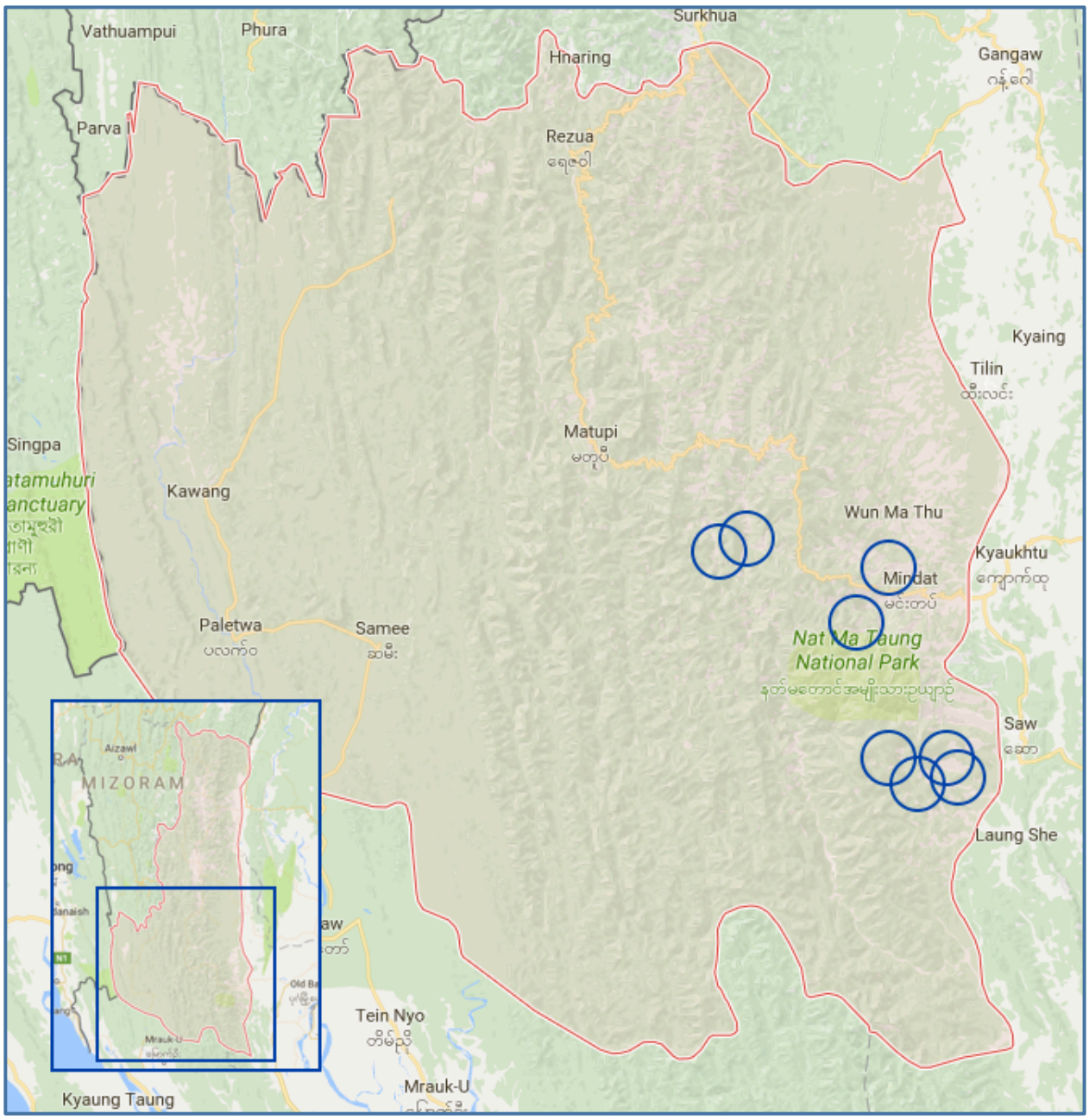
Table 2: Villages and Number of FGD Participants

Village	Township	No. of FGD Participants
Par Kun	Kampetlet	10
Kyaleihlen	Mindat	20
Phaw Ka Yaw	Mindat	26
Hnga Do	Kampetlet	20
Baung The	Mindat	16
Lun Don	Kampetlet	14
Auk Vi Ton	Kampetlet	18
Yoe Hpaung[2]	Mindat	31
All Villages	**n/a**	**155**

[1] Notable reports on the subject include: *Advancing Forest-Farm Producer Groups in Myanmar Within Market-led Community Forestry* (2013) by the International Institute for Environment and Development, *Report on the Study of Potential Products in Matupi* (2014) and *Elephant Foot Yam Processing and Commercialization in Matupi* (2015) conducted by Triangle Generation Humanitaire, and *Market Study and Value Chain Assessment* (2016) conducted by Adventist Development and Relief Agency Myanmar.

[2] This FGD included 31 participants from eight different villages.

Figure 1: Map of Villages Visited for this Study



3. History of EFY Industry in Chin State

EFY has been harvested and exported from southern Chin state for decades, traditionally as a foraged good found in forests. Chinese importers have sourced EFY from the region at least since the early 1990s. According to several sources interviewed, the price of fresh chip was less than 600 Ky/viss in the mid-to-early 1990s.[3] Around 1996, Japanese exporters became interested in EFY from Chin state as well. Japanese buyers tested soil suitability and mannan content of EFY from Chin. Although the account may be apocryphal, it is often reported that Japanese researchers found EFY from Chin state to be superior to that of other regions of Myanmar. By 2000, a number of early-adopters in Chin state began focusing on EFY cultivation as a cash crap, and some of these would eventually become dominant grower-traders in Mindat and Kampetlet. Several years later, the first donor-funded interventions in support of EFY production began when CARE supported EFY growers in 20 villages by providing slicers.

The Japanese export market for Myanmar EFY began to evolve in the 2000s. Japan has long grown its own EFY for domestic food manufacturing, and a 27.9% import tax was created to protect producers from foreign competition. However, as a Least Developed Country Myanmar was exempt from the tax up to a certain quota, and by the mid-2000s Myanmar companies were exporting processed EFY powder to Japan. At this time, Chinese EFY powder makers also began shipping powder via Myanmar and re-labeling to circumvent the Japanese tariff. In 2008 the Konjac Association was formed to verify that all powder exported from Myanmar to Japan was in fact produced in Myanmar. Once verified by the association, the Myanmar government would issue a Country of Origin certificate and the powder could be exported to Japan. According to one source, at least one EFY shipment from Myanmar was rejected as originating in China, and this put an end to fraudulent activity. In 2015 the Konjac Association was disbanded, although the quota remained in place limiting the volume of EFY imports from Myanmar.

Since 2010, EFY production in Chin state has matured further. In 2010 K&L Company (K&L) struck agreements with Chin farmers to buy chips, and Myanmar Belle Company (MBC) arrived in 2011. K&L started teaching large trader-growers how to produce thin chips, and in 2013 some town traders started passing these methods on to village growers. A year later, K&L started trading exclusively via Bokokuu. Yet another company attempted to establish a large chip drying operation in Mindat town, however this company and MBC both eventually ceased to source from Chin state. Also in 2013, EFY was moved from MOECAF to the Dept. of Agriculture, and as an agricultural product (rather than "forest" product) it became considerably cheaper to transfer out of Chin state because fewer permissions were needed. Around this time, more villagers in the study area began cultivating EFY rather than simply foraging it.

Today, most households interviewed in the study area cultivate EFY as their primary cash crop, however in some villages many farmers have yet to harvest their first yield. In 2012, growers and traders from 70 villages formed the Ar Yone Oo EFY Growers and Traders Association (AYO Association). In 2014 the AYO Association helped growers cooperatively sell chips to Mandalay, but this was discontinued the following year. Meanwhile, there have been some bumps in the market. According to several sources, there was one year in which Chinese importers purchased very little EFY and wholesalers lost money. However, today EFY prices appear relatively stable amidst slightly increasing demand in both the Chinese and Japanese markets. the Japanese never really served as a competitor to the Chinese market. Furthermore, several sources report that Chinese buyers, like the Japanese, are increasingly interested in better-quality chips.

[3] *Viss* is a common unit of measurement in Myanmar equal to 1.63Kg. Because growers and traders generally quoted weights in viss, this unit of measurement is used throughout the study.

4. Background: Cultivation, Processing and Markets

4.1 Taxonomy and Characteristics

EFY is a member of the genus *Amorphophallus*, of which there about 120 species widespread in the tropics and warm temperate areas of Europe. *Amorphophallus* usually produces a single leaf each year that can grow to a height of more than one meter in the wet season, depending on species.[4] With the onset of the dry season the leaf withers and falls off the plant, and each wet season it grows back. The subterranean tuber produced by the plant increases in size for three to four years, at which point it develops a single flower head rather than a leaf and ceases to grow larger.[5] The tuber is generally harvested at this stage and used for food or various industrial and medicinal purposes. Interest in the tuber generally derives from the presence of the polysaccharide gluco-mannose (mannan), which is viscous when combined with water.

While this study does not attempt to define the species encountered in southern Chin state, three varieties of EFY should be distinguished.[6] These are differentiated by internal tuber color and the presence of leaf bulbils, or the growths on the leaves that may be used for vegetative propagation. The variety most often grown in the study area is a pink tuber. Growers and traders claim that pink EFY has a higher mannan and lower moisture content than the other two varieties, although this could not be confirmed. Perhaps more importantly, the yellow and white varieties reportedly do not produce bulbils, and this may explain why they are seldom cultivated in the study area.[7] However, there is a slightly different perception of EFY varieties among Mandalay wholesalers. Although the white variety is said to produce smaller tubers that do not keep as long, some wholesalers said they command a 10% premium over other varieties. Meanwhile, yellow EFY is least favored by these wholesalers. Because most growers in the study area cultivate pink EFY, unless otherwise stated this study will heretofore refer to the pink variety only.

4.2 Cultivation

All growers interviewed for the study indicated that they now only cultivate tubers on private property, however EFY was once foraged in the forests of southern Chin state. The movement from forest to garden cultivation was due in part to the disappearance of wild tubers as EFY became more lucrative, as well as policy changes which removed barriers to garden cultivation (see 5.2 Enabling Environment). As wild tubers became scarce villagers collected small tubers from the wild and transplanted them in home gardens. A number of villagers expressed a preference for earlier practices of shifting cultivation that involved cutting and burning re-grown bush, as this entails the least weeding and highest yields. However, the decline of shifting cultivation and lack of ownership of large areas of land means that most villagers now cultivate EFY in backyard garden plots. Today, planting in gardens always occurs at the outset of the wet season.

---

[4] The plant's erect structure is colloquially known as a "stem," however botanically it is the petiole of the single leaf.

[5] For the purposes of this report, a 'yam' is an edible tuber and the terms will be used interchangeably.

[6] One of the most common species of *Amorphophallus* cultivated worldwide is *A. konjac*, usually referenced simply as "konjac." EFY conventionally refers to the larger tuber species *A. paeoniifolius*, however this report will refer to all *Amorphophallus* types encountered in the study as EFY.

[7] Some Mandalay wholesalers claim that yellow EFY is less valuable than pink, and pink less than white (commanding a 10% margin). However, other interviewees insist that the color of the fresh EFY tuber cannot be discerned from looking at dried chips.

Village growers often cultivate EFY in relatively infertile soil, and only the largest growers utilize inputs for improving soil fertility. The preferred soil type is one that is naturally fertile, probably with significant humus content, and well drained. Clayey and waterlogged soils are not suitable. Nonetheless, the study observed EFY grown without fertilizer in nutrient-poor household plots. Only the wealthiest growers—typically also EFY traders—apply any nutrients to EFY fields. No industrial fertilizers are used at all, however in some cases animal manure from cattle (or in one instance pig and goat) is applied. Villagers, by contrast, do not have access to animal manure. EFY is weeded two or three times per year, with more intensive weeding in the first year. Some large growers stressed that they retain weedings for application as fertilizer for EFY.

Intercropping was observed in some instances and growers in the study area were querried about best practices. Most growers indicated that shade is required for the best EFY production, however all virtually gardens observed in the study were open with few shade trees. Several growers indicated that the best trees for interplanting with EFY are those with small, bipinnate (finely divided) leaves and pods, suggesting that natural legume trees are considered the best. Several gardens were observed to have such trees, but none appeared to have significant density of them. Larger growers may cultivate EFY among coffee shrubs and avocado trees, although intercropping with legume shrubs was not observed. Villagers sometimes intercrop with household vegetables, although this was not observed in the fertilized, well-grown EFY fields of grower-traders.

There appear to be no significant pests or diseases affecting EFY in the study area. Growers occasionally cited damage from wildlife such as deer and rats, and two growers indicated damage from an insect that girdled the base of the petiole causing it to die and impact tuber growth. In some cases, minor insect attacks on growing tubers were observed, however growers were unable to identify the insects. The study observed no pest or disease control measures beyond protection against damage from domestic livestock.

4.2.1 Propagation Material

True seed.[8] After three or four years, the EFY flower bears roughly 200 tiny red seeds which may be collected in the early dry season. Although these offer plentiful planting material, they are rarely kept or sown. According to growers, this is largely due to the seed's long maturation time. One seed requires about five years to develop into a large tuber. Planting seed also requires additional labor for initial sowing, weeding of the small seedling in the first year, and transplanting it from a nursery in the second year. Very few more prosperous growers reported propagating EFY by this method, and only one villager. However several village growers reported scattering seed throughout their field without special care and harvesting whatever survives.

Leaf bulbils. Growers collect bulbils at the end of the wet-season when the leaf has fallen to the ground, and they are the most favored propagation material. The most prized bulbils are larger ones that form at the junction of the petiole and the laminae (i.e. the "leaves" or leaf blades) as these are reputed to produce the largest tubers.[9] Leaves derived from planted tubers produce bulbils every year. First-year leaves may produce as few as six smallish bulbils, but after three years a mature leaf may produce more than 20 bulbils that are preferred by growers. These may

[8] All propagation material is colloquially referred to as "seed." However, in botanical terms only the propagation material from flowers is true seed. The remaining parts used for propagation are vegetative in origin and are not true seed.

[9] These larger bulbils are said to occur atop what is colloquially referred to as the "stem."

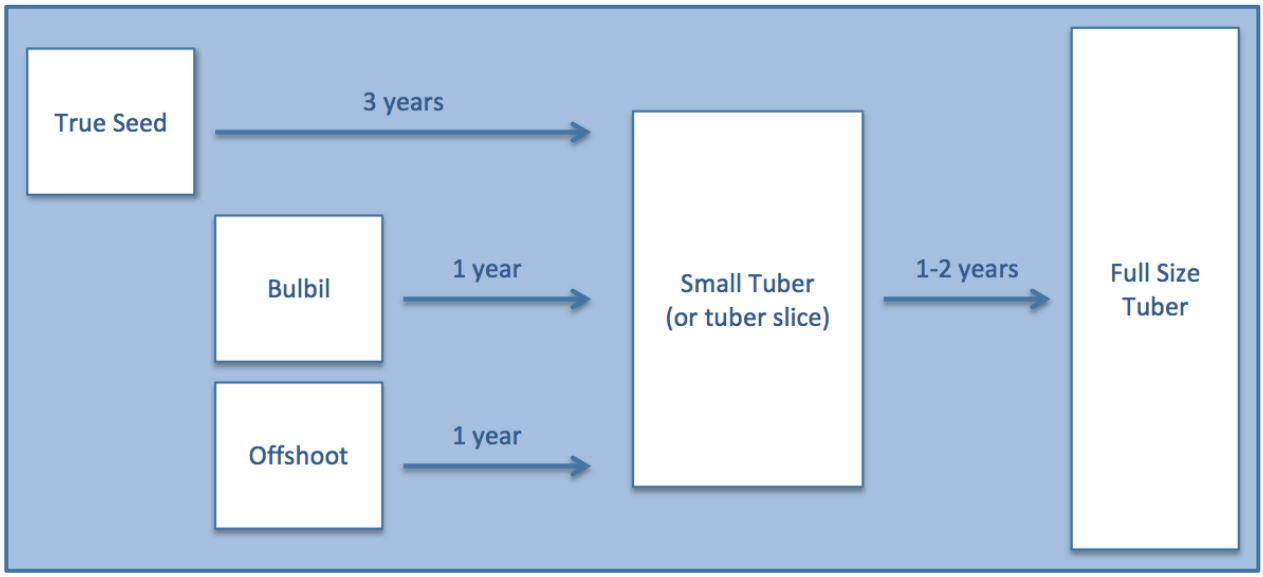
be sown densely in nurseries (about 25 per square meter) and transplanted the following year, or sown directly without transplanting (often about four per meter, but variable).

Tubers. There are three methods of growing EFY from existing tubers. Small tubers—either foraged in the forest or cultivated by growers—may be re-planted and harvested after one or two years.[10] Growers sometimes favor this planting material, because if it is on the larger-side it can reportedly produce a much larger harvestable tuber in just one year (or two years if it is smaller). An alternative approach involves cutting one large tuber into vertical wedges and planting these separately. Each wedge may develop into a harvestable tuber after one or two years. However, this method requires that one large saleable tuber be sacrificed to plant about four wedges, and growers face the risk that these wedges will rot on the cut surface and fail to grow. Growers may dry and dress the cut with fire ash to reduce the risk of failure, however this approach to planting is relatively uncommon in the study area. Finally, growers may plant the offshoots of mature tubers, either from developing "eyes" on the main tuber or from smaller tuber offshoots that sometimes develop on the roots. Planting by this method was not common in the study area.

Photo: EFY bulbils from a grower's garden in Lun Don.

[10] These small tubers are colloquially called "corms," however botanically *Amorphophallus* produces only tubers (not corms).

Figure 2: Planting Material and Time to Maturation



4.2.3 Harvesting and Storage

As EFY has moved from the forest to the garden, the harvest period in southern Chin state has shifted from late in the wet season to late in the dry season. Foraged EFY was previously collected near the end of the wet season, because once leaves had dried and fallen to the ground the tubers would be impossible to locate. Foragers also collected earlier because wild tubers might be claimed by someone else if not taken immediately. Because EFY is now cultivated in private gardens, growers have the luxury of marking the location with stakes and harvesting much later or periodically over time. Today, harvest occurs as early as November and as late as April. Tubers are best collected just before the wet season when they flower, as this indicates maturity and maximum weight of the tuber. Nonetheless, growers often harvest much earlier as income is needed (e.g. for Christmas celebrations). Several village growers also mentioned a shortage of labor, suggesting that harvesting later can smooth labor supply by spreading the workload over a longer period. However, growers prefer to harvest no later than February or March as this provides time to slice and dry before the wet season sets in.

The process of harvesting, as well as storage, is simple. Growers dig tubers out of the ground with a narrow blade or other iron hand implement, taking care not to puncture the exterior as this can lead to lead to rotting. Although tubers may be sold or processed immediately, in other cases they are stored in open bins or simply on the ground near the foundation of the house.

4.3 Chip Processing

4.3.1 Cutting

Cutting typically involves very little preparation. Tubers are not peeled, although growers sometimes wash them or use a steel brush or other implement to free them of large particles of adhering soil. There are two methods for cutting. Village growers in the study area generally cut tubers by hand with a basic knife. This is relatively simple, however it can be slow and result in uneven chips that are prone to drying unevenly. Some villagers and all larger growers use a hand-operated cutting device. These washboard-like “slicers” are designed to allow the user to slide the tuber over a stationary blade that is adjustable for thickness, thereby cutting more

quickly and evenly than with a knife. These slicers retail in Pakokku for 15,000 Ky but are fairly simple and could be easily made in local towns. In general, village growers choose knives over slicers, and several villagers possessed slicers distributed by NGOs, which they did not use. Villagers stated that they did not use slicers because they are cumbersome to use, more time consuming, produce slices that are too thin, risk cutting one's hand when slicing the last piece of tuber, or expose the person cutting to irritants in the tuber.[11] Others said that they did not know where to obtain slicers or that they were too expensive.

Most growers cut "thick" chips about one inch wide, and this is the most significant decision in chip production as it impacts the quality and quantity of chips produced. Thin chips are generally associated with higher quality, as they dry faster and are less affected by fungal rot (visible as black coloration, particularly on the inside of the chip). However, cutting thin also results in lighter chips due to the loss of water weight from better drying. Growers generally agree that cutting "thin" chips requires a tuber-to-chip ratio of 7:1 viss, while cutting "thick" chips requires in a ratio of 5:1 viss (i.e. one viss of thin chips requires seven viss of tubers, while one viss of thick chip requires only five viss of tubers). Growers also say that cutting thin chips requires more labor (based on the assumption that the cutter is using a knife).

Photo: A grower-trader in Kampetlet town demonstrates a slicer.

[11] Growers frequently stated that the fluid inside tubers—which contains irritants like alkaloids and calcium oxalate—cause the skin to itch or burn. Consequently, villagers often enclose their hands in plastic to avoid the itchiness from prolonged exposure. Wealthier grower-traders use plastic gloves, and in some cases face masks.

4.3.2 Drying

Growers employ a variety of techniques for drying chips. Typical drying methods for growers include drying on the roofs of houses, tarpaulins on the ground, or trays with a porous base (often coarsely woven bamboo) placed outside on shelves. In one instance, a large grower dried chips suspended on horizontal wires and also planned to dry chips on flat racks of wire mesh. Growers reported that drying chips on galvanized metal roofs can cause them to rust and is therefore not preferred. Growers invariably report that the major challenge to proper drying process is misty weather or unexpected rain, which raises the risk of fungal damage. Adequate space for drying was not mentioned as an obstacle to chip production.

The stated drying time ranged from one day to one month. Although it was not clear that any one drying technique was associated with faster drying times, larger and more sophisticated growers reported faster drying times.[12] One large grower reported drying in one day by suspending chips on wires, however most growers cited drying times of three days or more. Most village growers cited drying times of a week or longer, however one reportedly dries in just three days during March-April, which is the hottest and driest period of the year. Drying which takes one month is likely to produce chips blackened by mold that and fetch a low price. While one report suggests that "solar dryers" that use clear plastic have proven successful in Matupi, none of the growers interviewed for the study had encountered such a technique.

Box 1: Charcoal and Sulfur Drying

Drying methods for EFY chips vary throughout Myanmar, and outside Chin state it is not uncommon for producers to dry chips using charcoal fire. An oven-like structure is constructed from relatively simple materials, and chips are dried on trays that are protected from the rain. The advantage of this process is that it dries chips quickly and thoroughly—particularly during rainy season—however the drawback is that the charcoal blackens the chips in a way that wholesalers dislike. Some producers then use sulfur to bleach the chips, however this too is frowned upon by traders. Mandalay wholesalers said that Chin chips are often higher quality than those from other regions because the prohibitive cost of charcoal forces them to sun-dry chips. Of course, this also results in a large portion of fungus-blackened chips as well. While Chinese wholesalers and one Japanese exporter clearly favor sun-dried chips, another Japanese purchases charcoal-dried chips and uses an expensive technology to remove the sulfur through an alcohol washing process.

4.4. Powder Processing

Dried chips are processed into EFY powder, which is exported as an intermediate good in the overseas production of processed foods. According to one Yangon processor, the process essentially involves removing fiber in order to isolate mannan. The machinery required for doing this is quite expensive depending on specifications, such as volume capacity, energy supply, automation, and chip quality. One source suggested $100,000 USD as a mid-range price for a single machine.[13] According to one processor, there are three grades of increasingly-refined

[12] One large grower reported drying thin chips on the ground in just three days.

[13] This figure is somewhat dubious. The same figure was cited elsewhere as the value of a relatively outdated processing machine purchased years ago.

powder and Myanmar produces only the lowest grade.[14] By contrast, processors in China and Japan have the technology to further refine low-grade EFY powder into a high-grade powder suitable for food production. The chip-to-powder ratio can vary depending on the quality of the powder produced, although the most reliable estimate suggests Myanmar processors achieve a 12:1 tuber-to-powder ratio, or nearly a 2:1 chip-to-powder ratio. Unlike cutting and drying there are no seasonal restrictions on powder production, and the product can be stored for a year or more without quality reduction.

Table 3: Cultivation and Processing Calendar

Activity	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April
Land preparation								✓	✓	✓	✓	✓
Planting	✓✓	✓										
Weeding		✓		✓		✓						
Collection of wild tubers (for planting)	✓	✓										
Collection of wild tubers for (for sale)	✓	✓	✓	✓	✓✓	✓✓						
Collection of wild bulbils (sale or planting)						✓	✓					
Collection of cultivated tubers (sale or planting)							✓	✓	✓✓	✓✓	✓✓	✓
Collection of cultivated bulbils (sale or planting)					✓	✓						
Collection of seed for planting							✓	✓				
Slicing / drying of wild tubers					✓	✓	✓	✓				
Slicing / drying of cultivated tubers								✓	✓	✓	✓✓	
Sale of bulbils	✓	✓										
Sale of fresh tubers						✓	✓	✓	✓			
Sale of dried chips								✓	✓	✓	✓✓	✓✓

4.5 Markets

4.5.1 Export Markets: China and Japan

The study found evidence of only two export markets for Myanmar EFY. The Chinese market is the larger of the two by volume and value and focuses exclusively on dried EFY chips. Myanmar traders have exported EFY to China at least since the early 1990s, although it is rumored that farmers in Yunnan may be growing EFY as well. Chinese traders import the chips for processing into low- and high-grade EFY powder and eventually processed foods like noodles. The study found no evidence of Myanmar powder or any other EFY product besides dried chips being exported to China. EFY bound for China is traded via Mandalay and enters China's Yunnan province at the 105 Mile border trade zone between Muse and Riuli. Because this study focused on the value chain within Myanmar, little is known about further processing in China.

The Japanese market is both smaller and younger and is focused exclusively on EFY powder. Japanese processers import Myanmar EFY powder in order to refine it into a much finer powder

[14] Chinese and Japanese processors produce the highest-grade EFY powder using lower-grade Myanmar powder as an input.

and eventually produce a jelly-like food called *konnyaku*. Japan has a long history of growing EFY domestically in Gunma prefecture, just 75 miles northwest of Tokyo, however in the 2000s it began importing powder from Myanmar as well. Domestic production in Japan is protected by a tariff on EFY imports, however Myanmar benefits from tax-free imports up to a certain quota. The quota reportedly changes from year to year and the study received conflicting reports as to whether the it is met each year, however most sources suggest that the quota is generally around 350 tons of powder per year.[15]

Other export markets for EFY powder are rumored to exist, however this study found no evidence of those markets. While some sources suggest that powder is also exported to Singapore, Korea, China, and Malaysia, the study did not find any evidence of this at present.[16] Furthermore, Indian exporters are rumored to have considered exporting EFY powder from Myanmar at some point in recent years.

4.5.2 Domestic Markets

It is also worth noting the existence of local and regional markets for EFY products in Myanmar, both for intermediate goods and final consumer goods. There are local and regional markets for planting material and fresh EFY used in the chip and powder production process. Locally, planting material is bought and sold between farmers and traders at the village and town level.[17] There is also some evidence of regional markets for fresh EFY. Some grower-traders and wholesalers purchase fresh EFY from village growers for processing into chip. However the volume of this trade is small, presumably because transporting heavy fresh EFY is costly.

There is also a domestic consumer market for some EFY food products. The study found evidence of a small market for household consumption of fresh EFY in Yangon, where it is used in Indian curries. According to one Yangon trader, there is a small trade in non-irritant varieties of EFY from Mon state, which he sells in Yangon during certain festivals. However, none of the village growers interviewed indicated that they themselves cook or eat EFY. EFY is also used to produce two processed foods in Myanmar. One is a "fake meat" produced in Pyin Oo Lwin whose distribution is unknown, while the other is a noodle product produced in small quantities by a microenterprise near Yangon and distributed locally (see 5.1.5 Processors: Powder and Other).

[15] Several sources suggest the quota was 350 tons in 2011 and 450 tons in 2016.

[16] The ADRA report identifies export markets in China, Japan, Singapore and Malaysia, and one interviewee said that companies from China, Japan, Singapore and Korea import EFY powder (and that at least one Indian company has looked into it).

[17] The study found no evidence of regional markets for planting material, with one exception. It was reported by several interviewees that EFY planting material from Chin state had been purchased and transported down-country for use in growing operations in other states. This was purportedly done because of the reputation of Chin EFY as high quality. Nonetheless, there is no evidence of a sustained market.

5. Overview of EFY Value Chain

5.1 Actors in the Value Chain

5.1.1 Growers

EFY growers include villagers as well as some town traders and wholesalers who double as growers. Virtually all growers sell dried chips, although it is not uncommon to sell fresh EFY or bulbils when in need of cash.[18] EFY was the main cash crop for these growers, although other sources of income included avocado, coffee, or livestock. The EFY output of village growers varies greatly, ranging from 10 - 1000 viss of chips per household per year. Most villages have one or two large growers (usually early-adopters) and many smaller producers. Grower-traders in Mindat and Kampetlet produce much larger volumes of 300 - 1000 viss of chip per year, and the Pakokku wholesaler produces a massive 15,000-20,000 viss per year. Grower-traders have significantly more land than villagers (usually 3 to 12 acres) and are generally more advanced in their use of farmyard manure for fertilizer and paid labor for growing, washing, cutting, and drying. This was almost never the case among village growers, although some reported trading labor with neighboring growers. Village growers rarely reported receiving advance payment for EFY, although some traders said they lend to growers with the promise of receiving their chips at production time.

Village growers sell chips to town traders or intermediary collectors, while trader-growers sell directly to wholesalers. Growers sometimes store tubers and bulbils before making chips, but there were no reports of storing chips either in villages or towns. In most cases, villagers immediately transport EFY chips to town for sale. While some still carry chips by foot in baskets, in the past few years motorbike transport has become increasingly common. As an example, growers might pay 1500Ky to transport 30 viss of chips to a town one hour away, however there were also reports of trading motorbike access for labor. Traders or collectors also travel to villages, in which case the transportation cost is deducted from the selling price.[19] In one village three hours drive from Mindat, town traders arrive by truck in March-April and collect chips. All villages in the study area reported challenges dealing with town traders and agents, namely discrepancies between weights as measured by growers and traders and assessment of chip quality.

Table 4: EFY Output of Villages Visited[20]

Village	Township	First Year EFY	Total HH	HH selling EFY	Max viss/HH	Total viss (2016)
Par Kun	Kampetlet	2004	56	20	50	**600**
Kyaleihlen	Mindat	2005	66	66	1,000	**2,000**
Phaw Ka Yaw	Mindat	2005	26	26	600	**2,000**
Hnga Do	Kampetlet	2006	23	23	350	**1,000**
Baung The	Mindat	2008	32	32	300	**2,000**
Lun Don	Kampetlet	2011	24	20	200	**1,000**
Auk Vi Ton	Kampetlet	2014	23	5	100	**200**

[18] There were two exceptions in which villages sold mostly fresh EFY. For one village—very near Kampetlet—this is likely because proximity to town reduces the transport costs of fresh EFY and provides growers with other more lucrative opportunities to make 2500-5000 Ky/day as day laborers. The other village had only recently begun cultivating EFY.

[19] It was not clear whether these collectors are town traders, Mandalay wholesalers, or other intermediary collectors. Although it was not mentioned by any village growers, in Mandalay there were reports of some wholesalers traveling to Chin villages to purchase EFY.

[20] One focus group that consisted of villagers from eight different villages has been excluded here.

5.1.2 Collectors

In some villages, growers sell to intermediary collectors who transport EFY chips from village to town traders. The study did not interview any of these collectors and cannot say for certain whether they are more often independent freelancers or agents of town traders. The study also cannot estimate their number, however they appear to be relatively infrequent in villages within an hour of town and they are assumed to be more common in remote villages.

Collectors purchase EFY from village growers at a discount and sell onward to town traders, presumably at the usual town price. In essence, the village grower outsources the transportation function to these collectors. However, their added value is also that they provide convenience to the farmer by arriving at a time when the grower needs money. Nonetheless, growers report that collectors commonly under-weigh chips, perhaps even more than town traders. Collectors bring their own scale to the village and often remove 10% - 20% of the weight of EFY chips.

Photo: A Kampetlet trader displays a scale (measured in old batteries) commonly used in EFY sales.

5.1.3 Town Traders

Town traders in Kampetlet and Mindat are usually large growers who sell their own chips—along with that of villager growers—to wholesalers in Mandalay and Pakokku. There may be as many as 10-15 traders in one town, however growers reported that Mindat and Kampetlet each have three or four traders that do the majority of EFY trading. These traders also sell other

goods like tea, coffee or avocados. Individual traders handle 8000 - 100,000 viss of chip per year, and they source from 20 - 50 villages and perhaps as many as 100 different growers. According to traders, each grower provides 10 - 500 viss of chip per grower per year, although this is purchased gradually over the course of the dry season.

The activities of the town trader include sorting, storing and transporting EFY chips. Generally village growers bring chips to the town trader and the sale is negotiated in town. Town traders discriminate between chips by quality (good and poor) and pay growers different prices based on these characteristics. One trader who sells to both the Chinese and Japanese supply chains also sorts by thickness, as only about 40-50% of chips delivered are suitably thin for the Yangon processors. These chips are first weighed and then emptied onto the ground, separated by type, and re-weighed again. However, other traders employ a more cursory assessment of chips. Town traders have space for storing chips once purchased, and when they acquire enough volume they transport chips by bus or private truck to wholesalers in Mandalay and Pakokku. Traders report moving chips in shipments of up to 1000 viss, at a cost of around 70-100 Ky/viss depending on the season.

Table 5: EFY Output of Town-Traders Interviewed

Town Trader	Township	Supplier	Market	Viss (2016)
Trader 1	Kampetlet	50 villages	Mandalay	**8,000**
Trader 2	Kampetlet	30 villages	Mandalay	**10,000**
Trader 3	Mindat	<unknown>	Mandalay / Yangon	**10,000**
Trader 4	Kampetlet	50-100 growers	Yangon	**13,000**

5.1.4 Wholesalers: Mandalay and Pakokku

Mandalay Wholesalers - A small number of Mandalay wholesalers handle the great majority of EFY chips headed for the Chinese market. Three large wholesalers trade EFY chip in volumes of 300,000 viss/year or more. These wholesalers have warehouses on the periphery of Mandalay for storing large volumes of chip. Perhaps 50 or more smaller wholesalers deal in quantities of 10,000 – 100,000 viss/year and operate out of shop fronts in the town center. Mandalay wholesalers source chips from Chin state and elsewhere throughout Myanmar, including Rakhine, Kachin, Mon, and Kayin states as well as Tanintharyi region.[21] Two of the three largest wholesalers trade Chin chips, although just one handles the great majority of Chin chips. Mandalay's few large wholesalers also re-purchase chips from smaller ones in order to top-up supply when the price is good. Because small traders are located near Mandalay's central market or pickup from the bus station, they are easier to reach by town traders and are able to make a small margin off of this service.

Wholesalers store EFY chips before shipping them onward to Chinese traders. Wholesalers generally do not sort chips, although they do purchase chips at different prices based up on perceived quality. High quality chips are generally described as having little black color, coming from yellow or pink tuber varieties, having an even thickness, and being not so thin that they will crack or break in transport.[22] Several wholesalers stated that Chin chips are higher quality than other regions, largely because they are more often free of blackening caused by charcoal

[21] Some wholesalers referenced EFY chips from Rakhine state, however there is reason to believe that these may in fact be chips from southern Chin state. According to several interviewees, some EFY chips from southern Chin sate are shipped south by river from Paletwa. These chips—which originate in Chin state and transit via Rakhine to Mandalay—are quite possibly those which Mandalay traders purchase "from Rakhine."

[22] Traders and wholesalers believe that product weight is lost in transportation if chips crack or crumble.

drying. One trader stated that such chips command a premium of 500 Ky/viss. Wholesalers mentioned selling to 5 – 10 different traders located in Lashio or Muse, although they knew little about these traders. In some cases, the downstream traders come from Lashio or Muse to pickup chips, but this is less common. Wholesalers ship 10,000 – 20,000 viss per shipment and cover the entire cost of transportation. Transport costs are 80 – 100 Ky/viss, including a 5 Ky/viss local tax for leaving Mandalay and another tax at the Chinese border. It was not clear whether the point of sale is on the Myanmar or Chinese side of the border.

Pakokku Wholesalers - The study identified just one wholesaler in the Japanese supply chain, located in Pakokku.[23] This is the sole designated wholesaler for the one Japanese processor sourcing chips from Mindat and Kampetlet. The wholesaler reported purchasing from about twenty villages via two "agents" in Mindat town.[24] Like one town trader we interviewed, the Pakokku wholesaler sorts chips by type and quality and pays growers different rates for each category (this presumably occurs in Mindat and Kampetlet, not Pakokku). She estimates that 10-15% of the chips she purchases are not adequately thin for Yangon processors, and these are re-sold to Mandalay wholesalers.

The Pakokku wholesaler purchases chips on a 100 Ky/viss commission on behalf of the Yangon processor. The processor provides an estimate of the desired volume of chips at harvest time, and the wholesaler receives an advance payment to cover these purchases. In order to ensure that proper chip quality is achieved, between August and October the wholesaler visits villages to provide slicers and technical assistance on producing chips to the right specification. She said she supplied 140,000 viss of chips in 2016, and she expects this to increase to 160,000 viss in 2017. While she said that her total EFY chip volume is increasing, she did not provide a reliable estimate of what that amount is. The wholesaler arranges the transportation of chips to Yangon, however all costs are covered by the Japanese processor (by contrast, she covers her own transportation costs to Mandalay).

Table 6: EFY Output of Wholesalers Interviewed

Wholesaler	Location	Source	Market	Viss/year
Wholesaler 1	Mandalay	Chin (all regions)	China	**10,000**
Wholesaler 2	Mandalay	Chin, Mon	China	**10,000**
Wholesaler 3	Mandalay	Mon, Kachin, Rakhine	China	**50,000**
Wholesaler 4	Mandalay	Mon, Chin (all regions)	China	**50,000**
Wholesaler 5	Pakokku	Chin (Mindat, Kampetlet)	Yangon (Japan)	**140,000**
Wholesaler 6	Mandalay	Kayin, Tanintharyi	China	**300,000**
Wholesaler 7	Mandalay	Chin, Rakhine, Mon	China	**800,000**

5.1.5 Processors: Powder and Other

Powder Processors - The only EFY powder processors identified by the study are Yangon-based companies who export to Japan. Processors indicate that there may be as many as five companies exporting to Japan, however the study identified by name only two such companies—K&L Company and Myanmar Belle Company. Another company by the name of Universe previously attempted to export powder to Japan using Chin chips, but it has reportedly gone out of business. Once processing is complete, processors either store powder until the following year

[23] Other studies indicate that there may previously have been more wholesalers in Pakokku, and this was confirmed by one interviewee. However, by all indications these no longer exist.

[24] The nature of this Pakokku-agent transaction is not entirely clear. One source said that the Mindat agents and Pakokku wholesaler are in fact family members engaged in a single business operation, and this seems plausible.

or export it in 20-ton containers. Besides production and transportation costs, they pay a logistics fee of 4 - 6 lakh per 20-ton container and a 2% sales tax on the powder. According to one processor, EFY powder production also results in a byproduct that is sold domestically as animal feed.

K&L Company reported sourcing chips only from Chin state, while MBC sources all of its chips from regions other than Chin state.[25] Both processors are highly involved in EFY production at sourcing locations. Because there is no way to assess mannan content by looking at chips, these companies request multiple chip samples from traders before placing large orders. Both companies commission large regional chip-producers to supply chips, and in return they provide advance payment and technical assistance. Of the two, MBC appears to have perhaps achieved greater efficiency and larger scale.[26] Processors pay for all costs involved in transporting chips from wholesaler to processing facility in Yangon.

Other Processors - As discussed above, EFY is reportedly used in the domestic production of processed food products marketed within Myanmar as well. This study focused on EFY export markets, therefore relatively little was discovered about processing for the domestic market. However, the study identified one microenterprise near Yangon that processes such EFY products, and previous studies suggest that other processing may occur in Pyin Oo Lwin.[27] In the first case, one entrepreneur near Yangon is producing noodles with EFY powder purchased from Yangon processors. The processor reports that this product commands a relatively high margin, however it is currently produced in small quantities and sold only very locally. In the second case, there are reports of "fake meat" produced in Pyin Oo Lwin and added to soups and curries. This appears to be a relatively low-value-added product. None of the EFY wholesalers interviewed indicated that they sell dried chips to processors in Pwin Oo Lwin, and it is likely that these processors purchase fresh EFY locally in Shan state.

5.2 Enabling Environment

The administrative processes involved in growing and transporting EFY have been simplified in recent years, and previous studies explore them in some detail. Until recently, EFY was recognized as a forest product and transportation required approval from four different local and federal offices.[28] Around 2013, EFY was recognized as a "garden crop," at which point administrative procedures became simpler and the cost of transportation reduced by the avoidance of fees associated with forest products. Registering EFY as garden product still requires certification from several departments under the Ministry of Natural Resources and Environmental Conservation (MONREC) and Ministry of Agriculture and Irrigation (MOAI), however traders now view this as somewhat as a formality and not at all prohibitive to trade.[29]

There are several relatively standard government taxes involved in exporting EFY. For overland export to China, wholesalers reported paying a 5Ky/viss local tax upon leaving Mandalay as well as a fee of 65 Ky/viss at the border. By contrast, Yangon-based exporters serving the Japanese export market did not report paying any export fees. In order to export EFY powder to Japan,

---

[25] Although MBC did not say so directly, the interview suggested that it may source primarily from Mon, Tanintharyi and Kayin states.

[26] The primary differences between the two processors seem to be sourcing location, scale and volume of production, and acceptable methods for drying chips.

[27] Triangle Generation Humanitaire. (2015). *Elephant Foot Yam Processing and Commercialization in Matupi.*

[28] International Institute for Environment and Development. (2013). *Advancing Forest-Farm Producer Groups in Myanmar Within Market-led Community Forestry*.

[29] Triangle Generation Humanitaire. (2015). *Elephant Foot Yam Processing and Commercialization in Matupi.*

one processor reports that a Certificate of Origin must be acquired from the Myanmar government. Previously the country of origin was verified by the Konjac Association on behalf of the Union of Myanmar Federation of Chambers of Commerce (UMFCCI), however it is unclear whether another body still performs this function now that the Konjac Association has been dissolved.

5.3 Support Services

Support services for EFY production within the study area are limited and available from few sources. Over the past decade or so, these have included financing, equipment provision, technical assistance, and marketing assistance. Generally speaking, growers have received support services have been provided by three sources.

5.3.1 Downstream Actors

Perhaps the main source of support services to growers is downstream actors in the value chain to whom growers supply EFY. There are instance of town traders, wholesalers and processors each supporting upstream actors in order to ensure adequate EFY supply and quality, however the nature of this support differs significantly between the Chinese and Japanese supply chains. Within the Japanese supply chain, support includes financing, equipment provision, and access to technical assistance and training. For example, the Pakokku wholesaler receives an advance from Japanese processor and in turn pays an advance to growers in Chin state. Furthermore, both the wholesaler and town traders in the Japanese supply chain provide growers with equipment like slicers and technical assistance for slicing chips to the proper specification. Within the Chinese supply chain, support is limited to financing in the form of advances payments by town traders or wholesalers to the growers that supply them. The absence of technical assistance to improve chip quality is perhaps due to the fact that Chinese buyers absorbs all chips regardless of quality, albeit at reduced prices.

5.3.2 Grower Cooperatives and Trade Associations

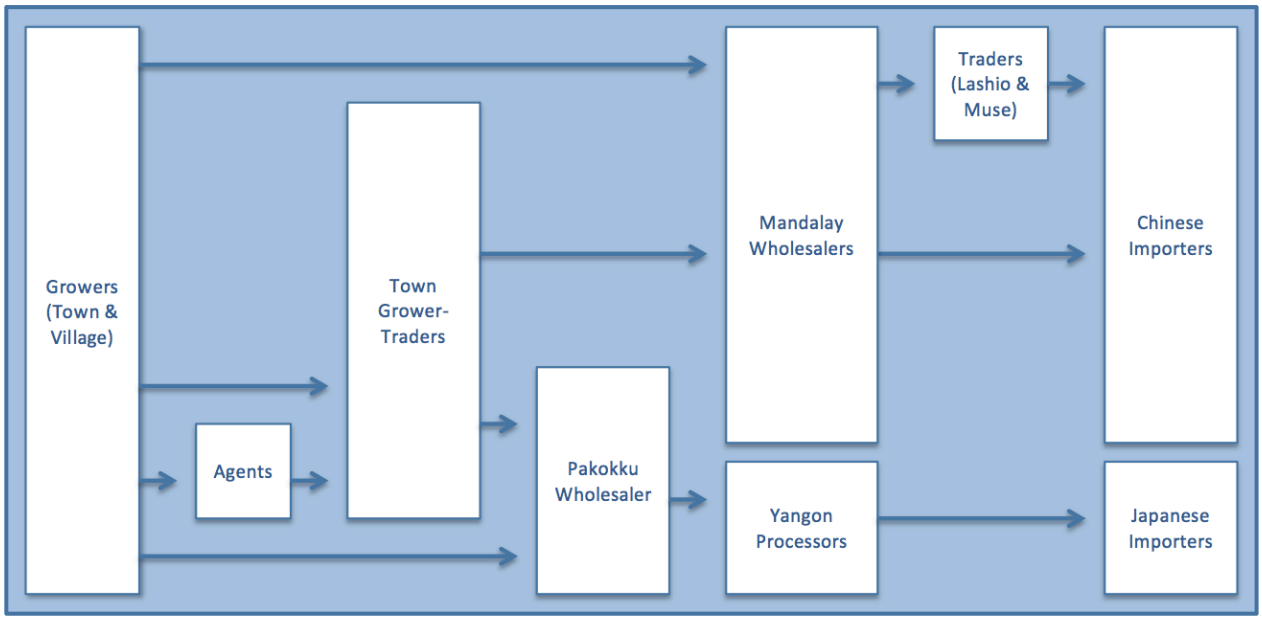
Other than very small-scale cooperation between households, the Ar Yone Oo EFY Growers and Traders Association (AYO Association) is the sole example of formal cooperation between EFY producers in the study area. In 2012, growers and traders from 70 villages formed the AYO Association with the goal of improving product quality and streamlining the regulatory environment for EFY production. The AYO Association has played a role in encouraging farmers to grow EFY in gardens rather than forage, and in 2012 it helped convince the Dept. of Agriculture to consider EFY a garden vegetable rather than a foraged forestry product, making it less costly for traders to market the product outside Chin state. Since then the AYO Association has also provided growers with assistance in marketing, skills training, and financing. In early 2014, the association facilitated cooperative selling among EFY growers in order to earn better prices from wholesalers in Mandalay. However, the effort faced some challenges—particularly as growers were unable to delay income in order to sell as a group (see 7.3.1 under Recommended Interventions)—and the experiment was discontinued the following year. The association continues to exist as a local partner for donor-supported interventions by nonprofit organizations such as Yangon-based Ar Yone Oo (AYO) and Triangle Generation Humanitaire (TGH).[30]

[30] The Yangon-based nonprofit Ar Yone Oo (AYO) should not be confused with the Mindat-based Ar Yone Oo EFY Growers and Traders Association (AYO Association). While the two have partnered to support EFY growers in Chin state, similarity between the names is merely coincidental.

5.3.3 Non-Governmental Organizations

A number of non-governmental organizations and other donor-funded organizations have provided assistance in Chin state in various forms. These actors include CARE, United Nations Development Programme (UNDP), AYO and TGH. The earliest interventions were those of UNDP and CARE, the latter of which reportedly provided slicers and seed grants around 2005. Since 2011, AYO has worked on EFY in southern Chin state, most recently providing slicers and business-matching services. In 2015 and 2016, AYO hosted two business-matching events to connect Chin EFY growers with powder processors and exporters in Yangon. However the organization described the intervention as only partly successful, and the program was wrapping-up in late 2016. AYO has also worked with Triangle Group to hold workshops in Kampetlet to inform improvements in EFY production in Matupi.

Figure 3: Sales Channels for EFY Products (Mindat & Kampetlet)



5.4 Sales Channels and Aggregate Output

5.4.1 Channels

The EFY supply chain in Myanmar consists of a few primary sales channels as well as several alternative options (see Figure 3). Growers typically sell to town traders located within a couple hours of town by motorbike, as this is the cheapest and most convenient option. However, as discussed earlier, there are also instances of village growers selling to intermediary agents and Mandalay wholesalers. Mandalay wholesalers also reported that Chinese traders once purchased directly from growers in Chin state, although this ceased some years ago. Town traders in Mindat and Kampetlet appear to supply exclusively to wholesalers in Mandalay or Pakokku, and no exceptions were found.

Mandalay wholesalers have a couple sales choices. Large wholesalers transport their own chips to Muse and sell to Chinese traders there or immediately across the border in Shweli (also known by the Chinese name Ruili). Mid-size wholesalers sell to downstream traders who come to Mandalay from Muse—or in some cases an intermediate location like Lashio—to collect chips. The smallest Mandalay wholesalers buy chips and re-sell them to larger Mandalay wholesalers.

They are essentially aggregators who enable larger wholesalers to top-up their supply when prices are good. Their central location near Mandalay bus stations and markets allows them to buy from town traders at a small discount, which covers their costs to transport chips to the wholesalers' large warehouses on Mandalay's periphery.

The Japanese supply chain is even more simplified, as there are few buyers. The Pakokku wholesaler is a dedicated agent of one Yangon-based company who does not purchase chips from Chin state through any other channels. Similarly, the two Yangon-based processors of EFY powder interviewed for the study each export to only one Japanese company.

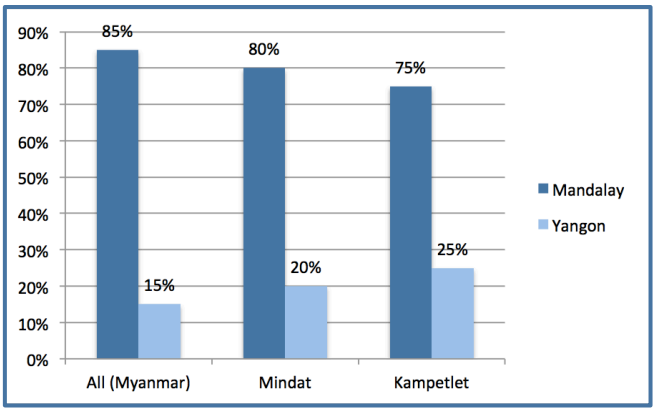
5.4.2 Aggregate Output

Total output of EFY in Myanmar is difficult to estimate given the absence of formal sales records and the fact that traders and wholesalers often report conflicting figures. One interviewee familiar with the three largest Mandalay wholesalers estimated that the Mandalay market accounts for roughly two million viss of chips annually, a figure which is not implausible given individual volume estimates provided by wholesalers. Volumes in the Japanese export market are uncertain as well, although the export quota for powder has reportedly been around 350-450 tons in recent years and this comports with figures cited by one Yangon-based exporter. Applying a 12:1 ratio of tuber-to-powder cited by two sources, this would amount to roughly 360,000 viss of chips annually in the Japanese supply chain. This suggests a total annual volume of 2.36 million EFY chips in Myanmar destined for the Chinese and Japanese markets. By this estimate, 85% of chips supply the Chinese market while 15% supply the Japanese market (see Table 7).[31] Poor wholesaler records make it difficult to know what portion of EFY entering the Chinese market is sourced from Chin state, although interviews suggest that Chin growers may supply roughly 40% of EFY exported to Japan.

Table 7. Total Estimated Chip Output in Myanmar (by Supply Chain)

Market	Chips (viss)	% Total Output
Japan (Yangon)	360,000	15%
China (Mandalay)	2,000,000	85%
Total	**2,360,000**	**100%**

Figure 4. Estimated % Chips Destined for Each Market (by Township of Origin)



It is even more difficult to estimate local output for Mindat, Kampetlet, or Chin state generally. An estimate of the total volume of chips from Chin state is beyond the scope of this study, as it focused on two townships only.[32] The volume of EFY produced at the town level is also difficult

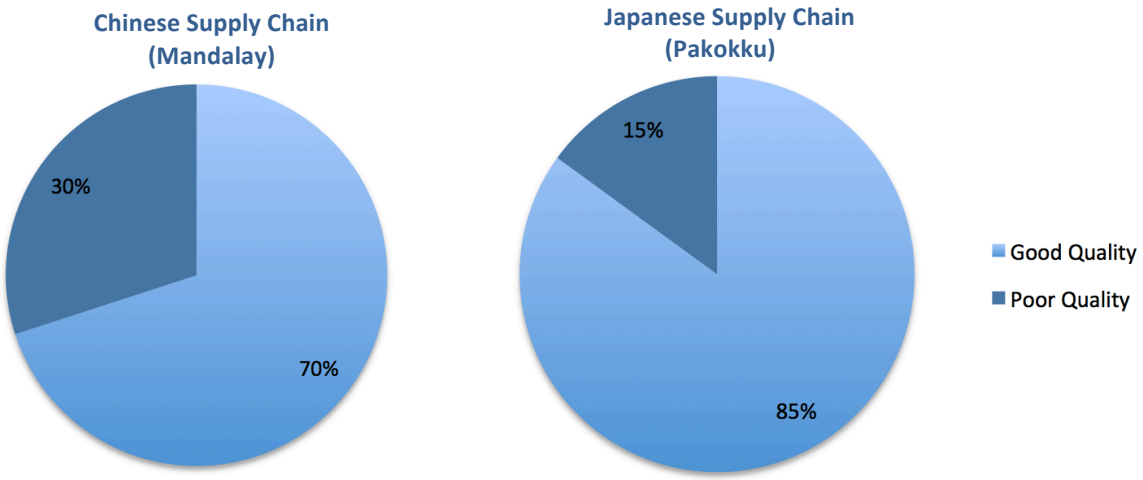
[31] If domestic processers in Pyin Oo Lwin make use of dried chip, this could be drawn from volumes within the Chinese supply chain. However, the study found no indication of this.

[32] It would be difficult to piece together total volumes from Chin state based on the estimates of Mandalay wholesalers, as wholesaler's estimates of chip volume by source may be fairly imprecise. Furthermore, the largest wholesaler of Chin chips was unwilling to be interviewed for the study.

to estimate. In Kampetlet, interviews with town traders suggest that the volume of chips entering the Chinese and Japanese supply chains may be around 40,000 and 13,000 viss/year, respectively. The study did not receive a reliable estimate of total EFY volume produced in Mindat. However, Mindat's largest town trader suggested that the Chinese and Japanese supply chains absorb 80% and 20% of Mindat chips, respectively, which comports roughly with estimated Kampetlet output. While these figures should be taken with a grain of salt, they do suggest that chip production in southern Chin may be slightly more tilted toward the Japanese supply chain than the rest of Myanmar as a whole. This is plausible, given that Chin state is one very few areas in which Japanese processors are reported to source EFY chips.

Estimates of EFY output *by quality* can be made with somewhat more confidence. Many EFY chips are considered low-quality for various reasons and therefore command a market price that is half the normal price or less. In the Chinese supply chain, the volume of low-quality chips appears to be fairly high. Growers estimated that between 10% and 40% of chips sold are discounted due to quality (30% being the most commonly cited figure), although trader estimates were somewhat lower.[33] In the Japanese supply chain, the figure is estimated be somewhat lower. The Pakokku wholesaler estimates that 10% - 15% of chips purchased are of insufficient quality for Yangon processors, either due to quality or thickness. It is reasonable to expect that these thinner chips would have lower rates of poor quality, because thinner chips dry more quickly and are therefore less likely to be impacted by fungus. Ultimately, however, these proportions should be taken merely as rough estimates.

Figure 5. Estimated % Good/Poor-quality Chips in Each Supply Chain



5.5 Value Addition

5.5.1 Price and Quality

The price of EFY chips has increased greatly in the past two decades, yet most actors in the value chain say that the price of high-quality EFY chips has remained relatively stable in the three to four years.[34] At least since 2014, the price of fresh EFY in Chins state has been around 600

[33] It is also possible that these discounts are due partly to traders simply cheating growers by claiming chips are poor quality (when they are not). However, even growers admit there is a large number of low-quality chips.

[34] One exception was a year in which the Chinese market bought very few chips.

Ky/viss. Most growers describe the price of good dried chip as ranging between 4000 - 6000 Ky/viss in recent years. At the time of the study, town traders were paying growers 4800 Ky/viss for thick chips headed for the Chinese market and 5000 Ky/viss for thin chips headed to Yangon processors serving the Japanese export market. In early 2016, planting material such as bulbils and small tubers fetched 2500-3500 Ky/viss and 1000-1500, respectively.[35]

In actual practice, however, the price sellers receive for EFY chips varies greatly based upon quality. The main factor that warrants a lower price are—as previously discussed—the brittleness of the chip, the evenness of the cut, the color of the EFY variety, and evidence of fungus or sulfur. Mandalay wholesalers in particular have many opinions on chip quality, most of which seem to be a repetition of preferences stated by downstream Chinese buyers. The most common and severe quality concern among all actors is how badly fungus has blackened the chips. Growers have sold fungus-blackened chips for as little as 1500 Ky/viss, although more often the discount is about 50% (see 6.1.3 Cutting: Thick or Thin). For instance, if high-quality chips sell for 4800 Ky/viss, then poor-quality chips generally sell for 2400 Ky/viss.

5.5.2 Production Costs

Production costs are relatively simple throughout the value chain. Almost all village growers collect their own bulbils for planting material and rely only on their own labor inputs. In some cases, village growers trade labor at harvest time. The largest out-of-pocket cost for village growers is transportation of EFY chips to town traders, which usually costs about 50 Ky/viss per hour distance by motorbike.[36] By contrast, town traders and wholesalers often have slightly more complex costs. For example, grower-traders usually invest in farmyard manure as well as labor for weeding, washing, cutting, drying, sorting and loading. Town traders in Mindat and Kampetlet quoted 100 Ky/viss for transporting EFY to Mandalay. Smaller wholesalers in Mandalay appeared to have only minor labor and transportation costs, although larger wholesalers must maintain storage warehouses and pay 80-100 Ky/viss to transport chips to the Chinese border. Unfortunately, the study was unable to estimate all of the costs faced by large EFY wholesalers or those involved in the production of EFY powder.

5.5.3 Value Capture

A full net margin analysis cannot be conducted without more information on downstream buyers and sellers of EFY chips and powder, however some observations can be made. First, transportation is a major component of cost for all actors. Transportation is main cost for village growers, and for town traders and wholesalers transportation amounts to 50% of profit. Second, growers capture the largest portion of value created in the value chain. Despite concerns of town traders and wholesalers cheating growers, these downstream actors capture a relatively small portion of value. This is not to say that this value distribution is fair—and probably traders capture somewhat more than they let on—but it does suggest that growers may see limited gains from retaining more value captured by intermediary traders and wholesalers.

Because this study was limited to analyzing the EFY value chain within Myanmar—specifically southern Chin state—it is impossible to paint a complete picture of the total value addition and value capture of Chinese and Japanese products produced from Myanmar EFY. Doing so would require tracing EFY as it changes hands in Chin and is refined into EFY powder and eventually

[35] It may seem counterintuitive that bulbils command a higher price per viss than (more mature) tubers, however it must be remembered that ten viss of fresh EFY contains only 5-10 tubers whereas 10 viss of bulbils contains about 300 tubers.

[36] A motorbike carrying 30 viss (approx. 50kg) costs about 1500Ky for a one-hour drive.

processed food products. While this is unknown, a snapshot of EFY products in China offers some context for understanding the EFY value chain. In China, various EFY products may be purchased wholesale (minimum purchase of one metric ton) at the prices listed in Table 9.[37]

Table 8: Value Captured by Each Actor for Thick and Thin Chips (per viss)[38]

Thick Chips for Chinese Market

Measure	Grower	Town Trader	Wholesaler
Selling Price	4800	5000	5300
Costs	50	100	100
Profit	**4750**	**100**	**200**

Thin Chips for Japanese Market

Measure	Grower	Town Trader	Wholesaler
Selling Price	5000	5200	5300
Costs	50	100	0
Profit	**4950**	**100**	**100**

Table 9: Price of Downstream Wholesale EFY Products in the Chinese Market

Product	Min. (USD/kg)	Max. Price (USD/kg)	Avg. Price (Ky/viss)[39]
Fresh Tuber	$1.00	$1.50	**2,784**
Dried Chip	$2.00	$8.00	**11,138**
Powder	$10.00	$20.00	**33,413**
Noodles	$24.00	$40.00	**71,280**

Unfortunately these prices are insufficient for completing a rigorous net margin analysis of the entire EFY value chain from tuber to final product. Yet they provide a baseline for conceptualizing the value addition that occurs once EFY products are exported from Myanmar.

Photo: A Kampetlet trader displays a tin of dried Chinese noodles made from EFY.

[37] http://www. alibaba.com. Accessed January 2017.

[38] Basic illustrative analysis based on the assumption that all chips are good-quality.

[39] Prices listed in USD and converted at current rate of 1350 Ky/USD.

6. Analysis of Value Chain

6.1 Analysis of Actor Choice and Rationale

Growers and traders face several choices in the value chain. This section does not purport to tell these actors which choices are best for them rather it aims to outline as best possible the key tradeoffs that actors face at each point in the value chain.

6.1.1 Planting: Bulbils, Small Tubers, etc.

Growers face several choices of planting material, but they invariably show great preference for bulbils. True seed can be acquired in large numbers from a single flower, yet it is rarely favored as it takes five to seven years to produce full-size tubers. Growers favor bulbils over small tubers as well. Small tubers mature one year faster, however they are more than ten times as expensive per-piece and they are difficult to transport. Furthermore, some growers report that small tubers simply never achieve full size, so grower confidence in this planting material may be lower.

6.1.2 Product: Planting Material, Fresh EFY, or Chips

Growers can choose to sell their product at several stages but show a preference for selling chips and planting material (i.e. bulbils) over selling fresh tubers. Bulbils are often sold to acquire fast cash at moments of need. In fact, for immediate cash, selling the twenty bulbils produced by the plant in a single year is more profitable (1400 Ky) than selling the mature fresh tuber itself (300-1000 Ky, depending on weight). Nonetheless, given the choice most growers would rather re-plant their own bulbils and allow them to grow. This is sensible, as the profit realized from a single bulbil increases 29x simply by allowing it to mature for three years to a full tuber. Furthermore, selling dried chip is also preferred over selling fresh mature tubers. On the one hand, dried chips are a higher-value product that allows growers to monetize more of their labor. Growers can increase the value of a fresh mature tuber by more than 49% in just weeks by cutting, drying and transporting it to market (see Table 10). On the other hand, dried chip also has roughly 8x the value-by-weight of fresh tuber. Because growers often face transport costs of 50Ky/viss, transporting and selling fresh tubers with all their water-weight is less profitable.

Table 10: Value Opportunity of a Single Bulbil (by Stage of Production)

Stage of Production	Year	Product	Weight (viss)	Price per viss	Profit[40]	% Increase in Profit (by stage)
1	0	Bulbil	0.03	2500	**69**	-
2	1	Fresh tuber	0.25	1000	**200**	**189%**
3	2	Fresh tuber	0.70	600	**322**	**61%**
4	3	Fresh tuber	1.00	600	**460**	**43%**
5	3	Dried chip (thick)	0.20	4800	**684**	**49%**

6.1.3. Cutting: Thick or Thin

Perhaps the most important choice growers face is whether to cut thick chips for wholesalers serving the Chinese market or thin chips for wholesalers serving the Japanese market. Most

[40] Profit is calculated after adjusting for weight, quality and transportation costs (see 6.1.3. Cutting: Thick or Thin).

village growers are aware of the Japanese supply chain and find the higher price appealing, yet for several reasons they generally favor thick chips. First, growers make more total profit by cutting thick chips. Although growers receive more per viss of thin chip, they can produce more viss of thick chips given a fixed number of fresh tubers (because thin chips dry more thoroughly and retain less water-weight). Second, growers face greater downside risk if they cut thin, for instance in the event they encounter poor weather while drying.[41] This is because while Chinese wholesalers will purchase all chips regardless of quality Yangon processor accepts only perfectly un-blackened chips. In theory, producing for the Japanese exporters could result in a loss of all sales for a season if quality is very poor. Third, there is a greater potential upside for producers of thick chips. While Yangon processors purchase a limited volume of chips each year—likely due to the Japanese import quota—Chinese wholesalers have historically absorbed as much volume as growers can produce. Finally, cutting thick chips requires less labor on the part of growers, therefore any added margin from selling thin must be large enough to justify the added labor investment from growers. The study suggests that these reasons provided by growers—not lack of access to or awareness of the Japanese market—explain the appeal of cutting thick chips for the Chinese market.

A brief analysis of the prices commanded by thick and thin chips appears to bear out the first point that thick chips offer growers more overall profit and better return on labor. Growers receive 4800 Ky/viss and 5000 Ky/viss for selling thin and thick chips, respectively, however these figures must be adjusted for several factors (see Table 11). First, town traders in the Chinese supply chain often play with weights when purchasing from growers, reportedly under-weighing chips by 10% - 20%. This is probably true in the Japanese supply chain too, although perhaps less so given the emphasis on maintaining consistent relationships with suppliers. Second, traders in the Chinese reportedly buy around 30% of chips at 50% discount due to quality. By contrast, the Japanese wholesaler rejects just 15% of chips on these grounds (although these too are then sold to Chinese wholesalers at a 50% discount). Third, the cost of transportation varies depending on whether she or he cuts thick or thin chips, because the former weigh more. When adjusted for these three factors, cutting thin chips generates 13.5% more profit *per viss* of chips, yet it reduces *overall output* by 28%.[42] As a result, 10 viss of fresh tubers harvested by growers generates 6836Ky and 5545Ky in profit for thick and thin chips, respectively. This amounts to a 49% and 21% return on labor for thick and thin chips, even before taking into account the added labor required by growers to cut thinner chips.

Table 11: Profit & Return on Labor (for 10 Viss Fresh Tubers), by Width of Cut

Width of Cut	Viss of Chips Produced	Expected Revenue	Revenue (weight adjusted)	Revenue (quality adjusted)	Profit (minus transport)	Return on Labor[43]
Thick	2.00	9600	8160	6936	**6836**	**49%**
Medium	1.67	8000	6800	6290	**6207**	**35%**
Thin	1.43	7143	6071	5616	**5545**	**21%**

As far as why a relatively small portion of growers produce thin chips—given the advantages of cutting thicker—this may best be explained the added benefits of the support services within the Japanese supply chain. For example, it appears more common for the wholesaler of thin chips to offer growers advance payments and technical assistance, both of which may reduce downside

[41] It should be noted that the Yangon processor for the Japanese market, unlike Mandalay wholesalers, also require samples of chips to be sent to Yangon where they are tested for mannan and sulfur content. This creates yet another hurdle for growers.

[42] These results are not very sensitive to variables other than width of cut.

[43] Return on labor is calculated as the percent increase in profit from selling dried chips rather than the fresh tubers required as inputs.

risk and entice some village growers to produce thin chips. That said, most growers seem to have detected the benefits of cutting thick chips and therefor choose to do so.

6.1.4 Drying Method: Ground, Roof, Rack, etc.

Drying apparatus is probably the next most important factor—after chip thickness—impacting product quality. It would appear from the analysis above that the key driver of grower profit is the ratio of tuber-to-chips, which is primarily due to water weight remaining in the chip. On the one hand, cutting thick chips retains water and increases the weight (and therefore the value) of the grower's product. On the other hand, doing this also makes the chips more susceptible to mold, reducing the value of the product. Therefore maximizing grower profit may involve striking a balance, which is to say drying chips sufficiently to sell without over-drying them and losing product weight. Achieving this may be more art than science, but growers are likely to be better served by drying as quickly as possible and thereby reducing the period during which chips are susceptible to mold.

The study was unable to quantify the impact of various drying methods on chip quality, but several observations may be useful. Contrary to expectation, one of the fastest drying times (three days) was reported by a large producer of thin chips who dries on the ground with tarps.[44] Drying method may be more important for thick chips in the Chinese supply chain. Amongst

[44] This is likely because the producer was drying thin chips.

producers of thick chips, large grower-traders invariably cited shorter drying periods than village producers, suggesting the two groups are doing something differently. Drying on the ground may be slower for thick chips, although some village growers report using racks and still dealing with much longer drying periods. In any case, village growers clearly remain extremely vulnerable to weather conditions that slow drying, increase mold, and reduce the value of their product. Growers seemed to believe that as long as weather is a factor drying will be a challenge. Other aspects of drying—such as the area required for each method—were not cited by growers as a limitation.

6.1.5 Sales Channels

For village growers, it is not clear that any one sales channel is better than any other, as different channels offer different benefits. Growers receive lower prices from agents and town traders than they would directly from wholesalers, yet these intermediaries provide an important service by transporting the product to market. The value captured by agents and town traders appears to be relatively small at 50-100 Ky/viss, even taking into account the fact that they reportedly under-weigh the product. Growers capture little added value by transporting the product themselves to Mandalay, so it may well be worth their labor to sell to intermediaries. That said, growers did feel that agents who visit the village play with weights more than town-traders, meaning they charge an added premium on top of the cost of transporting the product. But even agents offer some service to village growers over that of town traders, such as immediate payment and reduced risk of transporting chips to town and having to sell even if prices are low.

For town traders and wholesalers, the limited number of sales channels means actors face few choices in the first place. Only two large Mandalay wholesalers buy Chin chips, with one of the two reportedly buying the vast majority. Furthermore, although town traders have some capacity to store dried chips, this provides limited flexibility. Town traders report that thick chips continue drying further while in storage, thus losing more weight over several months and reducing revenue for traders. Roughly the same is true for Mandalay wholesalers.[45] Although small Mandalay wholesalers may sell either to larger ones or Chinese traders downstream, in general these wholesalers ultimately sell to a small number of traders in the Chinese supply chain and therefore face few possible sales channels. The one Pakokku wholesaler is a unique case, as she sells on commission to one Yangon processor. She has some added flexibility in her ability to sell excess chip to Mandalay wholesalers, but her position is not much different from other wholesalers in that respect.

6.2 Assessment of Market Prospects

The future of the Chinese and Japanese export markets for EFY chips and powder remains unclear due to lack of available information on foreign demand and competition. Without better data it is impossible to accurately project demand or prices into the future. Anecdotally, actors report that EFY prices have been stable for three or four years in both markets, with static demand in the Japanese market and slightly increasing demand in the Chinese market. Nonetheless, it is entirely possible that in the future growers in Chin state will face contracting foreign demand for EFY or stiffer competition from producers in Myanmar and abroad. The following sections therefore take a qualitative approach to considering the advantages and disadvantages of each EFY market, as well as the competitiveness of Chin growers vis a vis those elsewhere in Myanmar.

[45] Traders in the Japanese market have no choice of channels, as there is only one wholesaler for chips.

6.2.1 The Chinese Market: Large But Unstable

There are several reasons that the Chinese market for thick chips may appeal to EFY growers in Chin state. First, demand for chips is far greater in the Chinese market. The market absorbs more chips than the Japanese market, and because of this growers are always able to sell the chips they produce. All growers indicate they are confident that they can sell more chips in the Chinese market if they were to increase output. Second, the Chinese market purchases chips of all levels of quality, so growers are able to sell chips even if they are badly affected by mold, albeit at a discount. This provides some moderate level of insurance against poor weather (which growers cite as their largest challenge).

However, there are drawbacks to the Chinese market as well. First, there are a number of middlemen between chip-production and powder-production, and these actors capture value which could otherwise go to growers.[46] This contributes to a second challenge, which is that prices in the Chinese market have been known to fluctuate on a day-to-day basis, and this volatility increases risk for growers who are often forced to sell at low prices. Third, the Chinese market is poorly understood by growers and traders. There is conflicting information from wholesalers about what quality standards matter to downstream buyers in China, therefore it is difficult for growers to command a greater margin by meeting a high standard. Third, and perhaps most importantly, the future of the Chinese EFY market is highly uncertain. This is true both of quality and quantity. On the one hand, traders and wholesalers believe that Chinese buyers are increasingly concerned with the sulfur and fungal content of chips and may be less inclined to buy low-quality products in the future. On the other hand, Chinese growers in Yunnan are rumored to have begun growing EFY there, which could dramatically undercut the need to import EFY chips from Myanmar.

6.2.2 The Japanese Market: Smaller and Only Slightly More Stable

EFY growers may prefer to supply the Japanese market for EFY powder due to its relative simplicity, transparency and stability. For starters, the proximity of growers to Yangon processors means that there are fewer middlemen capturing value. Second, several factors produce more predictability in the Japanese market. The presence of a quota means that processors have a sense of the how much EFY powder they must produce in a given year. This information can be transferred to growers efficiently because they are dealing only with a single Yangon processor and dedicated wholesaler in Pakokku. Indeed, the study found that the Pakokku wholesaler commissions chips as needed based on advance volume estimates from the processor. This also leads to price stability for growers, as they are more often able to produce chips on commission with set prices. Lastly, as a lower-middle income country, Myanmar is perhaps likely to retain its tax-exempt quota at least in the medium-term.

However, there are also drawbacks to the Japanese market. First, it is more challenging for growers to meet the quality specifications. Even with better drying techniques, weather can make this difficult.[47] Second, there is limited and finite demand in the Japanese market. Although the study received conflicting information about whether the quota has been filled in recent years, there is nonetheless an absolute limit to the amount of EFY that the market can absorb and this presents the risk of excess supply in the future. Third, there is still some

[46] Mandalay wholesalers report 100-200 Ky/viss profit, whereas the single Pakokku wholesaler operates on a 100 Ky/viss commission.

[47] The rejection of low-quality chips in itself may not be a problem as these chips can still be sold in the Chinese market, albeit at a discount.

instability in the Japanese market. The quota is said to fluctuate year-to-year based on EFY production in Japan, therefore it is conceivable that a bumper crop in Japan could be harmful to Myanmar growers. More importantly, the price of chips in the Japanese supply chain is derivative of the price of chips in the Chinese supply chain (e.g. if Mandalay is paying 4000 Ky/viss, Pakokku pays 4100 Ky/viss), therefore instability in the Chinese supply chain may be transferred to the Japanese supply chain. If prices fall dramatically in the Chinese market, growers selling in the Japanese supply chain could face much lower prices too. In other words, year-to-year prices in the Japanese supply chain may prove to be just as volatile as those in the Chinese supply chain.

6.2.3 Domestic Consumer Markets

A larger market for domestic consumption of EFY products may be viable, however there remain a number of challenges and uncertainties, and this market may offer few opportunities to alleviate poverty among EFY growers in Chin state. As far as EFY noodles, a larger domestic market for such products remains unproven. It is worth noting that consumption of *konnyaku* in Japan is supported by a long history of medicinal use in the country that Myanmar does not share. By contrast, the production of "fake meat" in Pyin Oo Lwin is reportedly much larger and has an established place in the diet of some communities in Myanmar. However, if the main input for Pyin Oo Lwin processors is fresh EFY tubers (rather than dried chips) then the transportation costs from distant Chin state may prohibit growers from serving this market. While processing could be performed locally in Chin state, is also worth noting that this product may not command a high enough margin to significantly improve incomes for growers.

6.3 Competition Within Myanmar

There is ample reason to believe that Chin growers face stiff competition from other regions within Myanmar. For starters, large portions of EFY within both the Chinese and the Japanese supply chains are already sourced from regions other than Chin state. In the Japanese supply chain, as much as 59% of chips may be sourced from outside of Chin state.[48] Sourcing is less clear in the Chinese supply chain, however all Mandalay wholesalers indicate that they purchase chips from regions other than Chin state. Second, particularly in the Japanese supply chain there is evidence of producers achieving economies of scale in EFY production that could present a great advantage in cost-reduction over Chin state production. One processor reported working closely with chip producers—particularly in Mon, Tanintharyi, and Kayin states—to purchase large quantities of fresh EFY and using centralized technical assistance to process EFY tubers into high-quality thin chips. Consequently, a lowest cost structure could eventually price Chin growers out of the Japanese market.

Nonetheless, Chin growers may possess several competitive advantages vis a vis other Myanmar producers. First, Chin EFY carries a reputation for being higher quality than EFY from other regions of Myanmar. Within the industry, growing conditions in Chin state are reputed to be particularly favorable to EFY production. However, there is evidence that this reputation may have less traction among Yangon processors, whose purchases are more based on lab-verified evidence of mannan content. Furthermore, there have been numerous reports of EFY planting material being taken from the Chin State to plant elsewhere in Myanmar, so there may be no long-term advantage for Chin state producers as far as the genetic superiority of its EFY. Second, Chin EFY may also hold some marketing advantage as "organically produced" products, because most Chin farmers cannot afford industrial fertilizers, weedicides or pesticides and the

[48] One Yangon processor claimed to produce 59% of EFY powder exports while purchasing no chips from Chin state growers.

chips are only sun-dried (not dried with charcoal and sulfur). This could be advantageous in both the Chinese and Japanese markets, although it is uncertain that this is an advantage that cannot be replicated elsewhere given suitable agronomic practices and proper growing conditions. Additionally, one Yangon processor has the technology for removing sulfur from chips, negating one aspect of the advantage.

7. Recommended Interventions

The following section proposes specific short- and long-term interventions for increasing the income of EFY growers in southern Chin state. Throughout the field research, all interview subjects and focus group participants were asked to describe interventions that they considered to be most valuable for improving EFY production. The most common responses from growers and traders included the following:

- Village growers most often and vehemently voiced interest in the provision of planting material (i.e. bulbils) in the form of one-time grants to households.
- Growers also expressed significant interest in technical assistance for adopting new methods for improved drying of EFY chips.
- Villagers frequently complained about being short-changed by traders on the weight of EFY chips—especially collectors who visit villages—and desired better means to ensure that they receive the full value of their product.
- Traders and wholesalers invariably indicated a desire for better quality chips from village growers (i.e. moderately thin and evenly-sliced EFY chips that are free of blackness).

Based on these comments as well as the analysis in the sections above, this study proposes the following interventions for assisting EFY growers in southern Chin state.

7.1 Short-Term Interventions (1 Year)

In the short-run, targeted interventions may boost the income of EFY growers in the study area through the provision of production technology in combination with practical trainings. These interventions cover cultivation, processing (i.e. cutting and drying), marketing and sales. Strategically, they aim to address production efficiencies and improve product quality. In so doing, the interventions emphasize increasing value in the value chain over capturing larger portions of existing value. In all cases where the intervention involves the provision of materials, this is accompanied by training in their use. The interventions described in this section include:

- 7.1.1 – Provision of materials for drying (fishnet or solar), with training
- 7.1.2 – Provision of slicers and gloves, with training in operation
- 7.1.3 – Provision of leguminous seed
- 7.1.4 – Provision of natural mineral fertilizers, with training in soil fertility
- 7.1.5 – Provision of scales for weighing EFY at point of sale
- 7.1.6 – Facilitation of farmer exposure tours to demonstrate best practices
- 7.1.7 – Organization of in-room economic management skills trainings

7.1.1 Provision of Materials for Improved Drying: Fish Nets or Plastic

Provision of drying technologies may improve product quality by shortening the time required for drying. Buyers in both the Japanese and Chinese supply chains dislike chips with mold, and mold results from the presence of water in the chip over long periods of time. Better drying systems can therefore improve product quality by shortening the drying time and reducing the presence of mold. Several relatively simple technologies may enable quicker drying, some of which have been used with success in Matupi and could be trialed in other parts of southern Chin state.[49]

[49] Triangle Generation Humanitaire. (2015). *Elephant Foot Yam Processing and Commercialization in Matupi.*

One option includes an open, suspended drying apparatus constructed from fishing net that may be collapsed and stored indoors when the air becomes moist. One advanced grower in Kampetlet planned to use wire mesh for this purpose, however fishing net is relatively cheap and long-lasting and can be easily stored at night. However, one challenge is that when chips are stored at night chips those lying on top of one another may be more prone to mold. Another option includes small greenhouses (sometimes called "solar driers" or "hoop houses") which basically consist of small structures placed over black plastic groundcover and canopied in clear plastic. In essence, the black groundcover absorbs short wave radiation and converts it to long-wave radiation that is trapped inside the structure by the clear plastic canopy. The design is such that the hot, dry air naturally ventilates from a ground-level opening in front of the dryer and passes through chips sitting on porous trays. Most of the materials for the structure are available locally, however it is unclear whether the proper plastic is available. Sun exposure will cause ordinary plastic tarps to break down in 1-2 years, therefor the dryer should be made from UV-resistant plastic that will last for years.

7.1.2 Provision of Slicers and Gloves

Provision of adjustable slicers can improve product quality by improving the drying process for growers. Poor slicing that is either too thick or uneven is one contributor to poor drying. Slicers enable villagers to slice to the desired thickness with an even cut that allows chips to dry more uniformly. An easily-adjustable slicer also allows growers to choose the chip thickness that is ideal for the market they choose to supply. The recommended slicers are relatively inexpensive—about 15,000 Ky each—and available for purchase in Pakokku. The design is simple and could even be improved with sharper blades and easier adjustability. Some village growers have already used slicers for years, while others have them but view them as too cumbersome. Therefore they must be provided along with training. When used properly, they may also allow growers to slice more quickly and reduce labor requirements. Because growers are concerned that slicers expose them to irritants in the tuber's fluid, slicers should be provided in combination with gloves and face masks to reduce discomfort that may discourage their use.

7.1.3 Provision of Leguminous Plant Seed

The provision of leguminous plant seed may help village growers sustain soil fertility thereby improving long run EFY yields. As previously discussed, village growers who cannot afford fertilizers report decreasing EFY yields with each successive crop. However, several growers indicated native leguminous trees in their fields help improve EFY yield because their fine, bipinnate leaflets decompose readily in the soil and replenish nutrients. Encouraging growers to sow leguminous plant seed may facilitate this process.

There are three possible approaches to improving soil fertility in this way. One approach is to trial the growing of larger perennial, nodulating legume trees in EFY orchards. *Parkia speciosa*, also known as "monkey cry," reportedly nodulates and could prove successful.[50] The tree also produces pods that sell at a good price, although the tree must grow for several years before doing so. The other approach is to sow rows of additional leguminous shrubs that are known to fix their own nitrogen. The best choice for this may be pigeon pea, which is widely grown in adjacent lowland areas and would be a suitable legume to grow in frost-free areas. It has a three-year lifespan comparable to EFY plants, does not grow tall, very readily nodulates, and produces an edible and saleable pod. Other candidates include *Leuceana leucocephala* (although it is best

[50] Kannaiyan (2002). *Biotechnology of Biofertilizer.*

suited to the more fertile soils), *Leuceana diversifolia* (more suited to the higher altitudes and frost-prone areas), and possibly legume shrubs like *Calliandra, Erythrina, Gliricidia,* or *Tephrosia*. Finally, a variation on this approach could involve trialing short-term herbaceous legumes between subsequent EFY crops. Rice Bean and grazing cowpea are viable candidates as both readily nodulate, and the former also produces a saleable seed.[51]

Nonetheless, there remain several concerns about the efficacy of this intervention. First, despite the claims of growers, none of the fields observed for the study appeared to have sufficient density of leguminous trees to make an appreciable contribution to soil fertility. Second, denser tree cover may have the side effect of inhibiting EFY growth.[52] Third, the intervention may be limited by the absence of other important soil nutrients not provided by leguminous plants, such as phosphorus and sulfur. Finally, such interventions have been attempted elsewhere in Chin state with limited success and may be difficult to execute.

7.1.4 Provision of Natural Mineral Fertilizers

The provision of natural mineral fertilizers, like rock phosphate and gypsum, may also help address soil infertility and improve EFY yields. Chin state soils are likely to be very deficient in nitrogen, phosphorus, and sulfur.[53] While the provision of nodulated leguminous plants described above will provide nitrogen to the soil, it will not improve phosphorus or sulfur levels (unless by mobilizing nutrients from deep within the soil). The provision of rock phosphate and gypsum may help remedy this situation. Both inputs are relatively inexpensive, and unlike artificial mineral fertilizers (e.g. 16-20-0) their application should not compromise the environmentally sustainable image of Chin state agriculture as they can be applied to the soil without industrial treatment. Rock phosphate and gypsum are readily available in Thailand, however it is unclear whether they are easily acquired in Myanmar. If provided, these inputs should be accompanied by training in application and soil fertility.

7.1.5 Provision of Weighing Devices

The provision of weighing devices may enable growers to capture more of the value they create. Nearly all growers complain that agents and traders underestimate the weight of EFY chips by 10 - 15% and therefore growers do not receive the full value of the product. Part of the reason is due to insufficient weighing devices, as described above. Quality devices—such as a platform and dial scale—may help villagers be more certain of the actual weight of their product. One challenge to this intervention is that traders may reject the scales, and growers have few alternative buyers if this is not resolved. Furthermore, if traders are persuaded to pay on actual weight delivered, they may offset this by simply offering a lower price. Nonetheless, the provision of better weighing devices may at least give villagers more confidence when negotiating by making the process more transparent, and it should prevent gross short-changing by agents.

---

[51] Ebony variety of grazing cowpea from Australia may be suitable.

[52] Another factor to consider is that not all leguminous trees nodulate and fix, or make, their own nitrogen fertilizer (de Faria et al. (2010). Journal of Experimental Botany). This is particularly true of the *Caesalpiniaceae* subfamily of legumes common in natural forests of Southeast Asia, most species of which have fine, bipinnate leaves. The observed beneficial effect of such leguminous trees may well be just a nutrient-gathering effect created by roots and mycorrhiza from surrounding soil, and/or the concentration of gathered nutrients in the tree and its leaves (Tomlinson *et al.,* (1995), Agroforestry Systems 30: 145-159). In such a situation of non-nodulating leguminous plants, there is not likely to be an appreciable increase of nitrogen in the whole plant-soil ecosystem.

[53] Potassium deficiency is less likely to be an issue in most of the Chin soils, however field trials may be conducted to confirm this.

7.1.6 Farmer Exposure Tours

Growers may be taken on "exposure tours" to meet other actors in the value chain to facilitate information sharing along the value chain. Growers currently have little information about the desired product specifications of downstream actors beyond the most immediate town traders. Similarly, Mandalay wholesalers report that they do not purchase many chips from Chin state because "they do not know anyone in Chin state." Exposure tours linking growers with actors at the township-level and further downstream in places like Mandalay, Pokokku, Muse, and Yangon can provide growers with market information about the desired product specifications of wholesalers and processors. It can also facilitate information-sharing and vertical linkages along the value chain (e.g. price-checking, advances, and commissions) that have mutual benefit for all parties involved.

7.1.7 In-room Training on Economic Management

In-room trainings could offer economic management skills to growers, particularly with regard to retention of EFY planting material for new sowing or expansion of EFY cultivation. Although many growers express an interest in expanding their EFY cultivation, few retain enough bulbils from their own plants to do so. A training course could improve retention by emphasizing the economic advantages of retaining bulbils as planting materials rather than selling them at times of economic stress. The challenge to this intervention is that farmers often face legitimate economic crises that necessitate selling bulbils even despite the economic losses that this entails. However, for some portion of the grower population this intervention may prove effective by reducing an information deficit in which growers may not fully understand the economic potential of keeping bulbils.

7.2 Long-Run Recommendations (3-5 Years)

Beyond one year, a number of opportunities exist for longer-term interventions in EFY production. However, market prospects and competition must be taken into consideration when assessing whether to pursue such activities. The following interventions have been identified for three-to-five year projects and could be explored further:

- 7.2.1 – Continuation and expansion of short-term interventions
- 7.2.2 – Establishment of village seed banks
- 7.2.3 – Construction of town-level storage warehouses for EFY chips
- 7.2.4 – Business-matching to encourage EFY processors to source from Chin state
- 7.2.5 – Market research into developing domestic markets for EFY products
- 7.2.6 – Policy support for community forestry and expansion of cultivated area

7.2.1 Continuation and Expansion of Short-Term Interventions

All of the short-term intervention described above could be further scaled in southern Chin state given an increased program budget and timeframe. Most of the interventions outlined are appropriate for existing growers, however several could be further scaled to additional villages. Furthermore, a lengthier program may offer added emphasis on introducing EFY to new growers who have not previously cultivated EFY.

7.2.2 Establishment of Village Seed Banks

The establishment of village seed banks could help growers weather household-level economic crises and thereby facilitate the expansion of EFY production among existing growers. As previously discussed, growers frequently sell valuable bulbils when in need of immediate cash. A seed bank trading in bulbils could allow growers to sell planting material to a cooperative bank in times of need and then repurchase them from the bank at planting time. Theoretically, a not-for-profit cooperative seed bank could resell bulbils to growers at better rates than those offered by typical bulbil traders. In essence, the seed bank would operate much like a micro-lending entity, with planting material as collateral. The greatest challenge to establishing such banks, however, involves achieving successful governance and the assurance of fiscal solvency. Nonetheless, there is ample literature on village banks to further explore the potential for such an approach.

7.2.3 Construction of Town-level Storage Warehouses for EFY Chips

Construction of storage facilities in town centers could help improve the prices received by growers from town traders. Growers state that they currently have little bargaining power with town traders, because once they have paid to transport EFY chips to town they have little choice but to sell their chips may, even if prices are low. A warehouse space in town where village growers can store chips could prove beneficial in several ways. First, village growers would be able to forego selling until prices rise. Second, the ability to store chips would increase the bargaining power of growers at the point of sale. However, there are several challenges to this intervention. First, such warehouses would have to be under the control of village or town associations and this would present governance challenges. Second, the intervention focuses on helping growers capture additional value from traders who already face relatively slim margins. That said, if storage spaces improved upon the services of town traders—for instance by somehow reducing loss of chip weight from further drying over time—then this could also increase the price paid by downstream actors.

7.2.4 Business-Matching to Encourage EFY Processors to Source from Chin State

Business-matching activities between Chin growers and Yangon powder processors could open up market opportunities for Chin growers by encouraging more Yangon processors to source EFY from Chin state. If it is correct that the Japanese quota for EFY chips is not currently being met, then there may be room for additional processors to source from Chin state. This could conceivably improve the bargaining power of growers by acting as a counterbalance to the Chinese market and increase the price commanded for thin chips by increasing demand within the Japanese supply chain. Yangon processors also have demonstrated a capacity to improve the EFY chip production of growers through technical assistance and advance payments. The primary difficulty of this intervention is that companies' choice in sourcing locations is depending on many factors (logistics, marketing, etc.) that cannot not all be addressed through business-matching exercises. For instance, AYO has focused somewhat on business-matching efforts between powder processors in Yangon and growers in Chin state and found the approach challenging. Furthermore, with only one known powder processors in Yangon not already sourcing in Chin state, it would likely prove very difficult to persuade new entrants to the market to source from Chin state.

7.2.5 Market Research into Developing Domestic Markets for EFY Products

Market research into the prospects of further developing Myanmar's domestic market for processed EFY food products could open up new opportunities for marketing EFY products that are more stable than those of existing foreign markets. Most promising, perhaps, is the production of noodle products using EFY powder processed in Yangon. Although at least one producer has demonstrated a proof of concept for such products, the potential for such a market in Myanmar remains uncertain. The primary advantage of demonstrating such a market is that it would reduce growers' reliance upon uncertain export markets, however it might also enable further value-add opportunities for growers and chip producers in the future.

7.2.6 Policy Support for Area Expansion and Community Forestry Development

At a policy-level, interventions that support the expansion of area available to village growers for EFY cultivation could help increased the income of village growers. In particular, enabling growers to cultivate EFY on community forestry land could prove fruitful if this land were assigned to poor villagers who currently lack land for expansion. Community forestry is particularly relevant in southern Chin state where much land—especially more fertile land—is owned by a few rich landholders as part of the traditional hierarchal system of land ownership. As a result, many growers must pay rent to landlords if they wish to expand EFY cultivation. Moreover, villager growers will be reluctant to pay rent and improve land for several years before EFY is harvested, and landlords may be reluctant to guarantee availability of land for such a long period. The allocation of community forestry land to poor villagers may somewhat alleviate this problem by giving village growers a longer guaranteed land tenure without the need to pay rent. Furthermore, in such spaces growers could be encouraged to grow EFY in an "organic" manner as described above.

One constraint with this intervention is that community forestry land requires that trees be grown in this space. Contrary to the assertion of many growers, observations of both small and large EFY growers revealed no evidence that shade is an important requirement for EFY production. In fact, a large number of trees will likely reduce EFY yields, particularly if those trees are not nitrogen-fixing trees. Therefore if EFY cultivation is to be promoted on community forestry land, care must be taken to ensure that conditions remain suitable for EFY production in the future and the land is not completely dominated by trees. Nonetheless, EFY can be planted in re-growing forest area of community forestry land at least for the first few years of forest regrowth.

7.3 Lower-Priority Interventions

The following interventions were discussed with village focus groups, however they were considered somewhere less feasible or impactful as described below. These interventions include:

- 7.3.1 – Capacity-building for farmer cooperatives
- 7.3.2 – Provision of propagation material
- 7.3.3 – Construction of a powder processing plant
- 7.3.4 – Support for charcoal-and-sulfur drying methods

7.3.1 Capacity-Building for Farmer Cooperatives

The formation or strengthening of farmer cooperatives, like the AYO Association, could aid growers by helping to disseminate technical skills, improve product quality, and strengthen growers' bargaining position vis a vis traders or wholesalers. As discussed above, the AYO Association has undertaken activities to improve the policy environment and enhance marketing, financing, and production of growers and traders. Such associations are perhaps most beneficial in assisting with production improvements, particularly by offering technical assistance to help growers improve cutting and drying techniques during processing. However, interviews with village growers suggest that cooperative marketing arrangements—namely, collective selling—may be less effective. It is not uncommon for village growers to occasionally sell chips jointly via an informal group of households, however the only instance of large-scale cooperative selling was coordinated by the AYO Association in 2014 and discontinued the following year.

Villagers who jointly sold chips to Mandalay wholesalers in 2014 identified two major challenges to this approach. First, the major challenge is that each village household has individual selling needs. Growers often harvest and/or process EFY as they need the cash, and different growers need cash at different times. When selling as a group, the grower must wait until the cooperative has collected a sufficiently large quantity of chips before the product is shipped and sold in Mandalay. Growers are paid only at this point, because the wholesale price fluctuates slightly day-to-day and is only fixed upon delivery to the wholesaler. Because growers often require immediate payment, most prefer not to delay payment by selling cooperatively, therefore they instead immediately sell individually to the town trader. Addressing this challenge would mean enabling the cooperative to pay growers in advance of the sale, or incentivizing growers to accept delayed payments. The first of these two approaches could be achieved if the cooperative were provided with seed funding, however it risks taking significant losses if EFY prices fall over the course of the harvest season. The other challenge identified in 2014 was that selling as a group created some tensions between growers who received different prices for chips sent in one large shipment. Some growers objected to receiving a lower price than their neighbors when they felt their chips were of equal quality (despite the provision of paper invoices after the sale).

Nonetheless, one additional concern with this approach is that it would appear to offer rather limited income gains for growers, due to the relatively small profit margins faced by town traders and wholesalers. Town traders and wholesalers appear to capture about 100-200 Ky/viss, or as little as 5% of the value of the product delivered to wholesalers. If the cooperative's primary function is to help growers capture more of this value—rather than increase value by improving the product—then there are only relatively modest income gains to be achieved by growers through this approach.

7.3.2 Provision of Propagation Material

Provision of planting material to first-time EFY growers could help more households benefit from the growing EFY as a cash crop. Access to planting material—in particular bulbils—was a major challenge cited by both existing growers and households who have not yet begun to grow EFY. That said, the likelihood of such an intervention helping current producers expand existing EFY production is dubious. Each planting reportedly produces at least six bulbils per year for two years, and germination percentage is said to be more than 50%. Consequently, growers who already cultivate EFY should be able to produce enough propagation material for their own needs as well as some expansion. It would seem that the main reason that existing growers

cannot sustain their own planting material is because they are forced to sell it for cash at times of financial need. It is not unrealistic for interventions to support the annual provision of bulbils to growers, nor is it certain that this would have the desired impact of expanding production for existing growers. The provision of planting material—in combination with assistance in economic management of these inputs—could nonetheless be of use to the relatively small portion of households who have yet to take up EFY as a cash crop.

7.3.3 Construction of a Powder Processing Plant

The construction of a powder processing facility in southern Chin state could potentially benefit EFY growers by enabling them to capture more value in Myanmar's EFY value chain. Because these facilities are extremely expensive, such an intervention would presumably involve the construction of a single processing facility that is cooperatively owned and managed by EFY growers. The provision of a processing facility would therefore also be accompanied by extensive technical assistance supporting operation and management. By vertically integrating EFY production, these grower-processors could arguably achieve efficiencies that enable them to remain profitable while exporting EFY powder to Japan at a competitive price. In so doing, this processing cooperative would distribute profits to growers who provide EFY and operate the cooperative.

However, this intervention presents a number of significant challenges. First, construction of such a facility would be extremely expensive. Although this study has not attempted to identify all the costs involved in constructing and operating such a facility, one machine alone may cost as much as $100,000 USD. Once other costs are included, the cost of constructing a processing facility may well be beyond the scope of a donor-funded intervention. Second, operation of a powder processing facility would require extensive technical assistance, as growers and even town traders struggle to master an entirely new business venture. Third, any processing facility in southern Chin state would have to compete with large Yangon-based companies already exporting to Japan, and there is little reason to believe that the cooperative's vertical integration would outweigh those companies' advantage as experienced enterprises. Finally, a cooperative processing facility is likely to encounter many of the same governance challenges faced in cooperative selling.

7.3.4 Support for Charcoal-and-Sulfur Drying Methods

The provision of materials and training necessary to conduct charcoal and sulfur drying could potentially boost the incomes of village growers by improving product quality through significantly shorter drying periods. Poor drying currently contributes to growers receiving steep discounts on the EFY chips, therefore by drying more quickly with charcoal and sulfur growers may be able to receive higher prices for products sold in both the Chinese and Japanese supply chains. However, this intervention faces several important challenges. Most importantly, both of both thick and thin chips are increasingly concerned with this drying method. The Pakokku wholesaler does not buy chips dried in this way, and Chinese wholesalers are increasingly concerned with its perceived health implications. Furthermore, annual charcoal and sulfur purchases are outside the budget of village growers in southern Chin, and a one-time provision of the necessary materials is unlikely to have a long-term impact on household income.

8. Appendices

8.1 Questionnaire

Village-level interviews took the form of semi-structured focus group discussions. The following questions served as guiding questions:

1. How many households are in this village?
2. How many households currently grow EFY?
3. When did villagers start to grow EFY?
4. What are the required inputs for EFY production? (seed, fertilizer, pesticide, etc.)
5. Where do you acquire planting materials? (bulbils, tubers, etc.)
6. What is the selling price of planting material? Average cost of planting material for one acre?
7. What product do you sell, and where do they sell it?
8. How do you transport the product to town for sale?
9. Do you get market information before selling? How?
10. How many viss of fresh tuber and dried chip are produced annually by a typical household? And the entire village?
11. What kind of equipment is used for slicing fresh tuber? (knife, manual slicer, etc.)
12. Where do you acquire slicers, and what is the cost?
13. Do you cut thin or thick chips? Why?
14. What ratio of dried tuber is required for chips?
15. What method do you use to dry chips? (sun, charcoal, etc.)
16. How long does it take to dry chips?
17. Do you receive cash advances for producing EFY?
18. Do collectors come to the village to buy chips? How does the price differ from town traders?
19. How many traders do you deal with?
20. What are the main challenges for EFY production?
21. What kind of activities or support could help you overcome these challenges?

8.2 Contact Information for Key Informant Interviews

Name	Title	Affiliation	Type	Phone	Date	Location
Ko Nyein Lwin	n/a	n/a	Trader	<unknown>	16-Sep-16	Yangon
Daw Thiri Yi Mon	Manager	K & L Company Ltd	Processor	09 976133049	16-Sep-16	Yangon
U Aung Myo Thant	Fmr. Founder	Konjac Association	Trade Assoc.	09 256038282	17-Sep-16	Yangon
U Aye Naing	Fmr. Rep.	Konjac Association	Trade Assoc.	09 799145411	18-Sep-16	Yangon
U Cin Khan Lian	Director	Ar Yone Oo	NGO	09 5101216	21-Sep-16	Yangon
Marc Le Quentrec	Head of Mission	Triangle GH	NGO	<unknown>	21-Sep-16	Yangon
U Ko Ko Aung	Director	Myanmar Belle Company	Processor	01 573520	23-Sep-16	Yangon
Daw May Thin New	Fmr. Director	Myanmar Belle Company	Processor	09 5111282	23-Sep-16	Yangon
Daw Tin Yawei Aung	Company Rep.	Myanmar Belle Company	Processor	09 5005734	23-Sep-16	Yangon
Ma Win Shein	Owner	Kabar Kyaw Trading Co.	Wholesaler	09 2015654	18-Sep-16	Mandalay
U Maung Maung	Owner	Shwe La Trading Co.	Wholesaler	09 2002282	19-Sep-16	Mandalay
Ma Chaw Su	Owner	Shwe War Htay Trading Co.	Wholesaler	09 5122938	19-Sep-16	Mandalay
Ma Zin Mar Nway	Owner	Myo Khine Trading Co.	Wholesaler	09 43003299	19-Sep-16	Mandalay
U Myint Zaw	Fmr. Staff	UNDP	NGO	<unknown>	20-Sep-16	Mandalay
Ko Kyaw Zin Myat	Owner	Sein Kabar Trading Co.	Wholesaler	<unknown>	20-Sep-16	Mandalay
Daw Yee Yee Win	Owner	<unknown>	Wholesaler	09 2004042	20-Sep-16	Mandalay
Ma Aa Lin	Owner/Trader	<unknown>	Wholesaler	09 2021366	20-Sep-16	Mandalay
U Mya Maung	Owner	n/a	Town Trader	<unknown>	17-Dec-16	Kanpetlet
Nu Dar (Sui Thang Nu)	Owner	n/a	Town Trader	<unknown>	18-Dec-16	Kanpetlet
U Paing Saw	Owner	n/a	Town Trader	<unknown>	19-Dec-16	Kanpetlet
U Na Hung	Co-Chairperson	AYO Association	Trade Assoc.	09 47170107	21-Dec-16	Mindat
U Phay Ling	Co-Chairperson	AYO Association	Trade Assoc.	09 47170111	21-Dec-16	Mindat
Daw Ling Awi	Owner	<unknown>	Wholesaler	09 47207990	22-Dec-16	Pakkoku