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Insight Brief
Myanmar
Nov. 2020

Insight Brief

Background

This insight brief complements the "Investment Analysis in Mangrove Ecosystems in the Ayeyarwady Region." This insight brief serves to provide a comprehensive overview and enhance understanding of the commercialization of nipa palm products and the production practices within the mangrove landscapes in the Ayeyarwady Region. This analysis can support design of specific actions targeted at promoting inclusive livelihoods and value chain development while supporting mangrove forest restoration and conservation efforts.

Nipa Palm Products in the Ayeyarwady Region

Value Chain Analysis

Executive Summary

Nypa fruticans (nipa palm) is one of the most widely distributed and useful palms in the mangrove forests of Southeast Asia. In recent years, research on nipa palm has focused on its potential to obtain products such as sugar and biofuel, alongside its traditional use in roof thatching and wall construction. In the Ayeyarwady Region of Myanmar, nipa palm (locally referred to as *dani*) continues to be utilized and commercialized primarily for producing sheets of nipa thatch. A cost benefit analysis shows an average annual net income from trading nipa leaves, either as bundles of nipa leaves or sheets of nipa thatch, positive and profitable for small-scale farmers involved in this activity. Yet, there is a slow development of other nipa palm value added products associated with the lack of integration of this resource into the strategies and action plans for the development of the agriculture sector and a lack of technical knowledge of the actors in the value chain for the potential development of multiple products. In neighboring countries, opportunities associated with nipa palm have been explored and identified, especially related to the production and processing of nipa palm sap into sugar and bioethanol. Both products have demonstrated a contribution in the net income of the farmers and an opportunity for labor recruitment and gender inclusion. The following analysis aims to support small-scale farmers located in mangrove habitat areas in identifying and potentially developing new sources of income that are inclusive, economically attractive, and environmentally sustainable. COVID-19 impact information at the production level is presented. Issues related to its impact were reportedly faced at the end of the nipa palm commercialization season affecting farmers' product turnover, increasing production costs, and imposing restrictions for market access. However, there is uncertainty of the real impact COVID-19 will have on the upcoming season.

Nipa Palm (Adobe Stock)

Methodology

The methodology for this insight brief is framed by a functional value chain analysis, identifying the main stakeholders/agents within the value chain, and emphasizing on the production stage of nipa palm products in mangrove areas. For the analysis, 24 nipa palm farmers across the mangrove areas in the Ayeyarwady Region were interviewed. Farmers were selected using a random sampling methodology from a list of nipa palm farmers compiled by village head.

Acknowledgement

This insight brief was prepared by a team led by Nina Doetinchem and composed of Sofia Ahlroth, Thiri Aung, Aye Ma Marlar, and Lesya Verheijen from the World Bank; Juan Jose Robalino and Aaron Russell from the Global Green Growth Institute (GGGI); and Catherine Lovelock and Sang Phan from The University of Queensland.

This report was produced under the overall guidance of Mariam J. Sherman (Country Director, Myanmar), Gevorg Sargsyan (Head of Office, Myanmar) and Mona Sur (Practice Manager, Environment, Natural Resources and the Blue Economy Global Practice).

This insight brief was supported through the collaborative work undertaken with Myanmar Government authorities including the Forest Department, Department of Fishery, Environmental Conservation Department, and the Ayeyarwady Regional Government and its departments' Townships. This report would not have been possible without additional inputs from multiple international NGOs and civil society organizations in Myanmar.

Valuable contributions to this report were made by, and appreciated from Thomas Baker, Christopher John Dickinson, Andrew Lee, Eunjin Choe, and Rhiley Allbee, all from GGGI.

Funding for preparation of the report from the Wealth Accounting and the Valuation of Ecosystem Services Partnership (WAVES) is gratefully acknowledged.

All photos by The University of Queensland.

Report No: AUS0001920

Myanmar

MM Blue Economy, Plastics & Climate PASA

Investment Analysis for Mangrove Ecosystems in the Ayeyarwady Region

October 2020

Environment, Natural Resources and the Blue Economy Global Practice

NIPA PALM

Nypa fruticans (nipa palm) is one of the most widely distributed and useful palms in the mangrove forests of the South, Southeast Asia, and Oceania (Tsuji & et al., 2011). In Southeast Asia, nipa palm has been traditionally utilized as roof materials, medicine, and its sap fermented to obtain alcohol. Despite its usefulness, scientific reports on biology of nipa palm and its potential uses are limited in the region. In recent years, research on nipa palm has focused on its potential use as a biofuel crop given its several advantages over other biofuel-alcohol crops; this includes its high alcohol content, no competition with other crops for agricultural land, and no bagasse disposal difficulties (Tsuji & et al., 2011).

In Myanmar, literature regarding nipa palm is limited, in spite of its varied and traditional utilization by local communities living near or in the coastal and estuarine mangrove forests as documented by Tin Win (2000), and Ono & Suzuki (2013). In the Ayeyarwady Delta, nipa palm is reported to be well-adapted to brackish water, with local people cultivating it along tidal banks. Among its uses, communities process the midribs of the leaflets as tying materials; they use burned ash of nipa palm fruits as an antiodontalgic to counter tooth-ache; and they use nipa palm as a stimulant substituting betel nut (*Areca catechu*). However, its main importance comes from the harvested nipa palm leaves used for roof thatching and for walling. The thatch element is made of leaflet bunches of nipa palm, which are fixed in place by thin strips of bamboo. In the Delta, residents find nipa palm to be an optimum plant resource given the leaflets characteristics of being soft and easy to work, its light weight creating less load on the house structure, and its morphology that allows it to drain water efficiently (Ono & Suzuki, 2013).

Under the Myanmar 'Law of Protection of the Farmer Rights and Enhancement of their Benefits' (2013), which aims to protect the rights of farmers possessing small plots and to enhance their benefits effectively, nipa palm land is defined as "Farm Land". According to the 'National Biodiversity Strategy and Action Plan' (2015-2020), nipa palm is one of the main agricultural crops in one of the six major agro-ecological zones of Myanmar: Delta and Coastal Lowlands. This zone (defined as: delta, lowland and coastal river outlets and estuaries; heavy rainfall – more than 2,500 mm) includes the administrative units of the Ayeyarwady Region, Yangon Region, Bago Region, Mon State, Kayin State, Taninthayi Region, and Rakhine State.

Nipa palm global utilization	
Mature leaves	Roof thatching, wall-partitioning of dwellings, roof of boats, umbrella, sun-hat, raincoats, baskets, mats, bags
Young leaves	Cigarette wrappers, for wrapping cooked rice
Petioles	Floats for fishnets, chopped and boiled to obtain salt
Main axes	Fishing poles
Leaflet midribs	Brooms and ropes
Dried petioles and stalks	Firewood and made into brooms (rare cases)
Outer layers of the leafstalk	Good-quality boards of intermediate density
Young seeds	Food in the form of sweetmeat and snack. Flavor in ice cream and local ice confections (Malaysia)
Mature seeds	Material for buttons
Buds and petals	Aromatic tea
Young shoots, decayed woods, roots, or leaves	Medicinal purposes (herpes, toothache, and headache)
Sap	Material of treacle, amorphous and for producing vinegar. Alcohol that is used as biofuel and distilled, or fermented beverage. Feed for pigs (Indonesia)

Table 1. Nipa palm global utilization
Source: (Tsuji & et al., 2011).

Based on this classification, the development of nipa palm is included under the 'Myanmar Agriculture Development Strategy (ADS) and Investment Plan' (2018-19 ~ 2022-23). However, there are no strategies or plans for its development as they are, for example, for rice. This analysis aims to highlight the importance of nipa palm in the Ayeyarwady Region, while identifying opportunities to support small-scale farmers located in mangrove habitat areas towards achieving greater financial gain through sustainable value chain development.

Box 1. Small-Scale Farmers

Small-scale farmers are typically defined as resource-poor individuals or groups of people involved in small-scale production (i.e. agriculture production facilities and processes), with small production volume and/or relatively small surface area; typically lacking technical and financial capacity and other resources to support expansion and/or individual certification.

Functional Value Chain Analysis

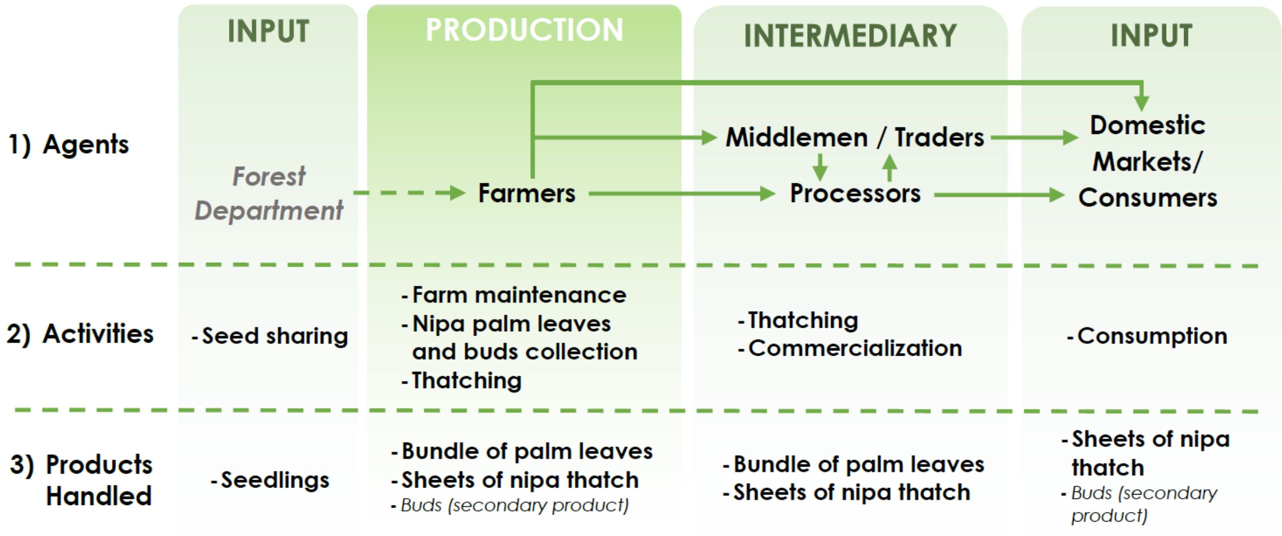


Figure 1. Nipa palm products functional value chain in the Ayeyarwady Region (small-scale farmers).

Along the value chain of nipa products produced and traded by small-scale farmers as an income source in the Ayeyarwady Region, sheets of nipa thatch are the finalized and most common product traded in local and regional markets. Leaves of nipa palm for thatching are harvested from December to May, with March and April being reported as the months with the greatest commercial flow. The main actors identified in the value chain include small-scale farmers, middlemen or traders, processors, and local and regional markets and consumers. While around 40% of the small-scale farmers surveyed reported to have agricultural training, no actor in the production stage reported to have received any kind of support for handling nipa palm farms and/or producing, processing, and commercializing nipa palm products.

Box 2. Gender Role along the Value Chain

The collection of nipa leaves was reported to be done only by men. Whereas for the thatching process, family members, mostly women, were involved in the process of picking and stitching nipa leaves. As for intermediaries, only men were reported to be involved in the commercialization of nipa palm products.

Input Stage

Nipa palm plantations (established through natural seed dispersal) are managed without nipa palm seedlings, fertilizers, and pesticides. Therefore, no major provider of production inputs was clearly identified. The Forest Department has supported small-scale farmers by sharing nipa palm seedlings; however, its role as an input supplier is not clearly defined, nor well recognized.

Production Stage

In the production stage of the value chain of nipa thatch, two types of small-scale farmers were identified. The first type of farmer collected nipa leaves and traded/sold them as bundles of nipa leaves (Figure 2). The second type of farmer collected nipa leaves and further processed them into sheets of nipa thatch (Figure 3). The majority of both types of farmers reported to being engaged in other farming activities, primarily the production of rice. However, the second type of farmers reported being more dependent (in relative terms compared to other sources of income) on their activities related to nipa palm. At the production stage, the collection of nipa leaves was reported to be done only by men.

Figure 2. Bundle of nipa palm leaves

Figure 3. Sheets of nipa thatch

Based on the information collected, on average, the leaf-selling farmers reported a productivity of 1,109.5 bundle/ha/year with an average farm size of 3.64 ha. The average price per bundle observed was 540 MMK. On average, farmers reported an estimated annual income from the sale of nipa leaves of around 1,400,000 MMK, equivalent to around USD 1,000. In terms of operational costs, no input costs were reported; maintenance costs consisted of weeding and cutting the stump of the palm border; while labor costs reflected the opportunity cost of the farmer, given the time and effort required to fully carry out the activity; and finally, transportation costs were reported. The average annual net income for these farmers is positive, with a net margin and benefit to cost ratio reflecting a profitable economic activity.

CODE	AVERAGE	UNIT	AVERAGE (USD/year)
Farm area	3.64	ha	
Productivity of nipa palm leaves	1,109.5	bundle/ha/year	
Gross Income	**1,376,900**	**MMK/year**	**$ 996.31**
Nipa palm leaves	1,376,900	MMK/year	$ 996.31
Operational Costs	**759,667**	**MMK/year**	**$ 549.69**
Production Inputs	0	MMK/year	-
Maintenance Costs	111,667	MMK/year	$ 80.80
Labor Costs	642,000	MMK/year	$ 464.54
Add. Labor besides the farmer	0	# people	
Processing Costs	0	MMK/year	-
Transportation Costs	6,000	MMK/year	$ 4.34
Net Income	**617,233**	**MMK/year**	**$ 446.62**
Net margin	0.45	%	
Benefit to cost ratio (BCR)	1.81	ratio	

**Reference Foreign Exchange Rate: 1,382 MMK per USD (Central Bank of Myanmar)*

Table 2. Leaf-bundle selling farmer operational information (1st type of farmer)

The second type of farmer, or thatch-sheet selling farmer, reported an average productivity of 24,945.3 thatch/ha/year with an average farm size of 5.66 ha. The average price per 100 sheets of nipa thatch observed was 4,200 MMK. On average, farmers reported an estimated annual income of around 4,500,000 MMK, equivalent to around USD 3,200. As the second type of farmer further processed the nipa leaves into thatches, the operational costs included maintenance costs (weeding and cutting the stump of the palm border), labor costs (reflecting the opportunity cost of the farmer plus additional labor reported), processing cost (which includes the cost of bamboo sticks used to connect the nipa leaves), and transportation costs. For thatching, family members (mostly women) were involved in the process of picking and stitching nipa leaves. Nipa buds were reported to be commercialized as an additional product by one farmer; however, the annual income from this product only represented 4% of the farmer's annual income from commercializing sheets of nipa thatch. The average annual net income for these farmers is positive, with a net margin and benefit to cost ratio that shows a profitable economic activity.

CODE	AVERAGE	UNIT	AVERAGE (USD/year)
Farm area	5.66	Unit	
Productivity of nipa palm leaves/thatch	24,945.3	ha	
Gross Income	**4,538,426**	**MMK/year**	**$ 3,283.96**
Nipa palm thatch	4,538,426	MMK/year	$ 3,283.96
Operational Costs	**3,072,343**	**MMK/year**	**$ 2,223.11**
Production Inputs	0	MMK/year	-
Maintenance Costs	198,565	MMK/year	$ 143.68
Labor Costs	1,259,444	MMK/year	$ 911.32
Add. Labor besides the farmer	1	# people	
Processing Costs	1,524,611	MMK/year	$ 1,103.19
Transportation Costs	89,722	MMK/year	$ 64.92
Net Income	**1,466,083**	**MMK/year**	**$ 1,060.84**
Net margin	0.32	%	
Benefit to cost ratio (BCR)	1.48	ratio	

**Reference Foreign Exchange Rate: 1,382 MMK per USD (Central Bank of Myanmar)*

Table 3. Thatch-sheet selling farmers operational information (2nd type of farmer)

Overall, the net income from the sale of thatching sheets is significantly greater than that from the sale of nipa leave bundles. However, according to this analysis, the net margin and benefit to cost ratio for the sale of thatch sheets is significantly lower than that of selling leaf bundles due to the greater labor cost involved. This should be presented with a caveat, that the production of thatching sheets will most likely be done at home during evening hours or other periods that do not compete with the rice production activities, and in reality represents a much lower opportunity-cost for labor.

Figure 4. Thatching process at farmers' level

Box 3. COVID-19 Impact at Production Level

Around 60% of all farmers surveyed reported to have suffered at some extend the impact of COVID-19, most of them being the ones who depend on nipa palm as their main economic activity. For those farmers that reported greater dependency on nipa palm economic activities, 50% reported to have faced product turnover issues, observing a delay in selling their products and a lower demand; 25% reported an increase in production costs, mostly related to an increase in the labor cost; and finally, 18% of the farmers reported to have faced issues related to market access, facing travel restrictions to visit some markets and/or the need to change the marketplace. However, farmers emphasized that issues related to COVID-19 impact were faced at the end of the nipa palm season (nipa palm thatch business is suspended during the rainy season). Therefore, there was uncertainty as to what the real impact of COVID-19 will be for the upcoming season.

Intermediary Stage

Small-scale nipa palm farmers either process the nipa leaves into sheets of nipa thatch and sell them directly to consumers or through a trader, or sell the bundles of nipa leaves to traders or thatch businesses for further processing. For those farmers commercializing through traders/middlemen, none of them reported to have a formal agreement in place. Despite this fact, 35% of farmers commercializing with intermediaries reported a credit system payment in which the trader leverages its operations over the farmer's operations. In other words, the trader pays the current product acquired in the next purchase or acquisition deal.

Regarding processors, local news has reported nipa palm thatch businesses as a convenient source of livelihood, providing attractive income to locals (earnings between 7,000 MMK and 8,000 MMK per day) (MDN, 2019). Despite the fact that demand for thatch is high, thatch businesses have observed a depletion of workers within this economic activity. A level of skill is required for picking and stitching nipa leaves; therefore, it is not an activity that anyone can accomplish according to local businesses. The reason behind the scarcity of workers is related to a shift to other economic activities, mostly related to crop plantation (MNA, 2016). This diminishing workforce for processing nipa thatch has pushed an increase in the market prices of nipa thatch, impacting its competitiveness against zinc sheets (MNA, 2016).

Market Stage

Sheets of nipa thatch are acquired and traded directly from farmers, traders, and at local and regional marketplaces. Sheets of nipa thatch are mostly used in low-income homes, livestock pens, and small commercial buildings. The future demand for sheets of nipa palm depends directly on people's choice, as they are increasingly using zinc sheets for roofing.

Figure 5. Thatch business

Opportunities

Besides the utilization of nipa palm leaves for thatching purposes, nipa palm provides other products that can become an important and stable source of income for local people. Extraction and commercialization of nipa palm sap represents a great opportunity for small-scale farmers.

Box 4. Nipa Palm Sap Collection as an Opportunity for Gender Inclusion

As mentioned in Box 2, under the current nipa palm products' value chain, women's role is limited to the processing of sheets of nipa thatch. The extraction and commercialization of nipa palm sap opens the opportunity for the integration of women into the production and processing stage, through the collection of nipa palm sap and primary and/or secondary processing depending on the final product.

Nipa Palm Sugar

In recent years, there has been a renewed interest in producing palm sugar from nipa palm sap across Asia, given its perceived health benefits ideal for diabetics, overweight people, and 'health-conscious' consumers (KELOLA Sendang, 2017). One of the health concerns related to sugar consumption is the glycemic index (GI). Consumption of products with a high GI has been associated to many health disorders (e.g. obesity, diabetes, and heart disease). Research has shown that palm sugar (including nipa palm sugar) has a slightly lower glycemic index than sugar derived from sugar cane; however, the benefit of palm sugar consumption for managing glucose levels is under debate and increased health claims due to this relationship are unsubstantiated. Moreover, many consumers do not see palm sugar as a healthy product. Consumer concerns about the healthiness of sweeteners relate primarily to the caloric value, and unfortunately, this level is high in palm sugars (CBI, 2016).

Traditionally, to obtain nipa palm sugar, nipa palm sap is collected, filtered, and poured into a large pan. It is boiled for 3-4 hours reaching a high concentration of brown sugar characterized by a viscous appearance. Subsequently, the hot sticky brown sugar is poured into a mold (made of bamboo, wood, or coconut shell), and cooled for at least one hour prior to being packed (Kurniawan & et al., 2018). Innovations have been made in the collection system (using flexible pouches or sterile plastic containers), but even more importantly, there have been improvements in the processing equipment, replacing the traditional direct heating in open pans with a modified fire-tube-steam jacket kettle (KELOLA Sendang, 2017). It should be noted that without the introduction of such innovations, the promotion for processing nipa sap (boiling/cooking) into sugar could create a significant demand for fuelwood. Given that a major cause of mangrove degradation in the Ayeyarwady Region is for fuelwood and charcoal production, a poorly managed promotion of nipa palm sugar production could precipitate a further source of deforestation.

Box 5. Nipa Palm Sugar in Pak Phanang Basin

In Pak Phanang Basin, Southern Thailand, income from collecting and processing nipa sap into sugar has exceeded other livelihood options. Around 4,850 farmers (60-70% of the population) are engaged in this activity, achieving constant production through sustainably harvesting nipa sap from 3,200 ha.

Source: KELOLA Sendang, 2017.

Bioethanol

Nipa palm sap can also be processed into bioethanol, which has an outstanding importance in economies that are seeking to fulfill their energy requirements and/or substitute the utilization of fossil fuels. The shift towards sustainable and environmentally-friendly energy sources has generated significant interest in developing biofuel from plant biomass. In this context, nipa sap has the potential to be processed into bioethanol, which can replace (or be mixed with) fossil fuels; can be utilized in beverages, cosmetics, in the health field (antiseptic substance); as a solvent, as well as an industrial raw material (Hidayat, 2018). For biofuel production, the single most important factor for success is the energy yield of the plant biomass chosen, ideally being as high as possible (Murdiyarso, Lasco, & et al., 2016).

Box 6. Bioethanol Production in Indonesia

Based on 2013 data, production of bioethanol was capable to contribute a net income of 6,095,274 – 42,039,360 IDR/ha/year (around 500 – 3,400 USD/ha/year). Evaluations showed that the labor recruitment on the utilization of nipa palm sap into bioethanol was able to generate up to 3.69 people/ha/month. This number was significant in order to increase the welfare of households when comparing to available or existing jobs. Additionally, it was observed that as nipa palm does not require much fertilizer or particular care, and since it is able to live longer and be tapped for up to 50 years, its utilization was more environmentally-friendly compared to corn and sugarcane.

Note: Foreign exchange reference rate Dec/2013 – 12,189 IDR/USD – Bank Indonesia
Source: Hidayat, 2018.

As a reference point, with a nipa sap tapping period of 100 days/year (under traditional management), and with a density of 1,000 palms per ha, an annual sap yield of 50,000-100,000 L/ha/year can be harvested. Consequently, the annual ethanol yield estimated is around 4,550-9,100 L/ha/year (Hidayat, 2018). Compared to other sources, sugarcane can yield (fuel-alcohol) 3,350-6,700 L/ha/year, cassava 3,240-8,640 L/ha/year, sweet potato 6,750-18,000 L/ha/year, and coconut sap 5,000 L/ha/year. It takes 13 liters of sugar-rich nipa palm sap to produce around 1 liter of bioethanol. The remaining 12 liters of residual can be used to generate a by-product known as Captured Liquid Carbon Dioxide (CLCD) that can be utilized as bio-organic fertilizer (KELOLA Sendang, 2017). By improvement in sylvicultural techniques and modernization of collection and processing, the amount of alcohol from nipa sap can be expected to increase up to 18,165 L/ha/year, which will make nipa palm a more attractive source of biofuel (Tsuji & et al., 2011). As an additional referential point, in the Philippines, nipa palm sap is being processed in mills set up to produce bioethanol from sugarcane. This has supported to fill the under-utilized capacity of the mills and reducing the average costs from processing bioethanol based only on sugarcane (KELOLA Sendang, 2017).

Box 7. Existing Biofuel Business Models in Myanmar

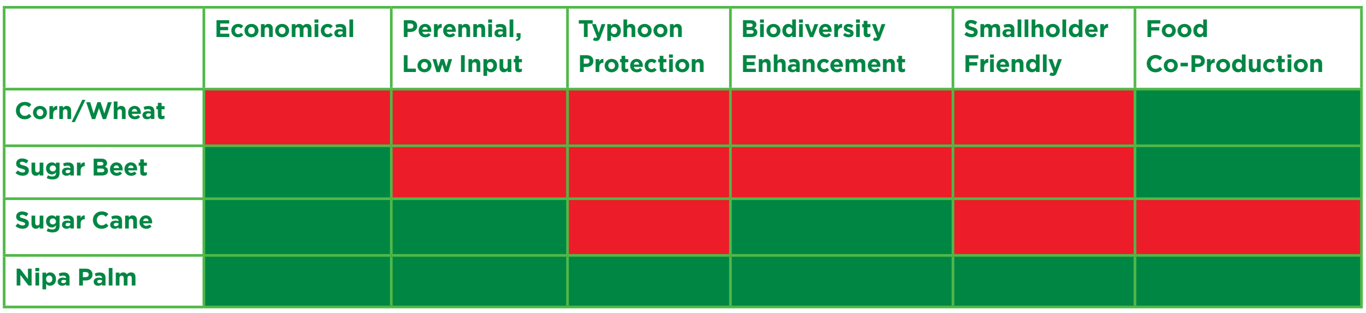
Alcohol distillation technology is reported to be established in Myanmar with different business models observed:

1. Small-scale ethanol plants using feedstock such as sugarcane, cassava, and corn, which are readily available in the villages;
2. Small- and medium-scale industries, which include ethanol plants with a capacity of 300-2,000 TCD (3,600-25,000 t/year of ethanol) using sugarcane, molasses, and sugar syrup; and
3. Large-scale industries, such as the Great Wall Ethanol Factory in Sagaing Division and Shweli Swan In Factory (36,000 t/year of ethanol) in Shan State.

Source: Asian Development Bank, 2009.

Additional Nipa Palm Benefits and Ecosystem Services

When compared with other agricultural crops, the nipa palm can provide a wide range of other societal and environmental benefits including coastal storm protection from typhoons, carbon sequestration, biodiversity, etc. (See Figure 6). However, it has been observed that total exploitation of mangrove areas to develop nipa palm habitats, which has continuously occurred, can potentially reduce the diversity of plant species significantly decreasing the overall ecosystem benefits. Therefore, nipa palm development requires a habitat conservation strategy in order to build and align the natural mangrove ecosystem service benefits with the additional potential socioeconomic benefits for coastal households (Hidayat, 2018).



*Color code: Red = No, Green = Yes

Figure 6. Comparing wider benefits among various agricultural ethanol feedstocks

Source: CIFOR cited in Murdiyarso, Lasco, & et al., 2016.

Conclusions

In the Ayeyarwady Region, nipa palm is mostly used for producing sheets of nipa thatch. The average annual net income from trading nipa leaves, either as bundles of nipa leaves or as sheets of nipa thatch, was positive and profitable for small-scale farmers involved in this activity. However, it should be noted that the commercialization of nipa thatch is a seasonal business activity whose future may be undermined by customer preference for zinc iron roofing materials. Absent of a significant additional source of income, the maintenance and cultivation of nipa palms on the landscape may be under threat.

Neighboring countries have already started to take advantage of the additional benefits that nipa palm offers, especially considering the attractiveness due to its generation of stable year-round labor demand, inclusion of different economic actors, opportunity for gender inclusion, and economic attractiveness and profitability.

a. As has been observed in Indonesia, the development of bioethanol production based on nipa sap not only represents an opportunity to contribute to the national energy requirements and substitute the utilization of fossil fuels, it also represents an opportunity to generate constant labor demand.

b. In addition, as has been seen in several SE Asian countries, there is a growing demand for healthier sugars, and there is significant demand for nipa palm sugar due to its lower glycemic index. However, innovations for the processing of nipa sap need to be carefully considered in order to avoid further mangrove degradation.

Overall, the development of nipa palm farms requires a landscape-wide habitat conservation strategy, to avoid the replacement of mangrove while maximizing the ecosystem benefits for coastal households.

Recommended next steps for development of nipa palm value chains

- **Conduct an analysis to determine if the current infrastructure in the Ayeyarwady Region can further process nipa palm sap, either for sugar or bioethanol.** For sugar, it is important to observe the capacity to process nipa sap without a major dependence on fuelwood for its processing.
- **Once the infrastructure capacity has been identified, analyze potential models to promote the commercialization of nipa sap, through an inclusive and environmentally responsible process.** This would need to include an assessment of the regulatory framework needed to support the sustainable development of this sector.
- **Explore options to promote and support the development of nipa palm farms and products through the existing institutions in Myanmar.** This will include, exploring the potential to include nipa palm in the strategies and plans for development, as well as clearly identifying the support and roll expected from government agencies. Additionally, other nipa palm products, such as nipa buds, should be considered and further assessed as potential complementary outputs that could support sustainable nipa palm production systems.

References

Asian Development Bank. (2009). *Status and Potential for the Development of Biofuels and Rural Renewable Energy: Myanmar.* Mandaluyong City, Philippines: Asian Development Bank.

CBI. (2016, September 16). *Exporting palm sugar to Europe.* Retrieved from Centre for the Promotion of Imports from Developing Countries: https://www.cbi.eu/market-information/honey-sweeteners/palm-sugar/palm-sugar-europe/

FD. (2015). *National Biodiversity Strategy and Action Plan (2015-2020).* -: Ministry of Environmental Conservation and Forestry.

Hidayat, I. (2018). *Economic Valuation of Nipa Palm (Nypa fruticans Wurmb.) Sap as Bioethanol Material.* Indonesia: Indonesian Institute of Sciences (LIPI).

KELOLA Sendang. (2017). *Exploring the Potential of Nipa Palm for Ecosystem Restoration and Climate Change Mitigation, Sustainable Rural Livelihood Change Mitigation, Sustainable Rural Livelihoods and Renewable Energy.* Mei: KELOLA Sendang.

Kurniawan, T., & et al. (2018). P*alm Sap Sources, Characteristics, and Utilization in Indonesia.* Journal of Food and Nutrition Research, vol. 6, no.9: 590-596.

MDN. (2019, August 21). *Nipa palm thatch businesses flourishing in Chaungzone Tsp.* Retrieved from Myanmar DigitalNews: https://www.mdn.gov.mm/en/nipa-palm-thatch-businesses-flourishing-chaungzone-tsp

MNA. (2016, April 24). *Nipa palm thatch industry vanishing for lack of workers.* Retrieved from The Global New Light of Myanmar: https://www.globalnewlightofmyanmar.com/nipa-palm-thatch-industry-vanishing-for-lack-of-workers/

Murdiyarso, D., Lasco, R., & et al. (2016). *Enhancing the Resilience of Coastal Wetlands to Promote Sustainable Livelihoods in Changing Climate.* -: Center for International Forestry Research.

Ono, K., & Suzuki, K. (2013). *Assessment of Subsistence Plant Resource of the Mangrove Forest in the Ayeyarwady Delta, Myanmar.* Yokohama: Global Environment Research.

The Law of Protection of the Farmer Rights and Enhacement of their Benefits, Law No. 32 (Pyidaungsu Hluttaw October 8, 2013).

Tsuji, K., & et al. (2011). *Biological and Ethnobotanical Characteristics of Nipa Palm (Nypa fruticans Wurmb.): A Review.* : Sains Malaysiana.