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# Showcasing a Village-Level Rubber Pale Crepe Processing System for the Farmers in Kidapawan City, North Cotabato, Philippines

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**ABSTRACT:** The study aimed to showcase the village-level rubber pale crepe processing system in Kidapawan City, North Cotabato, Philippines by establishing a processing system, actual operation and marketing of product, test the quality of the product, willingness-to-pay by the farmers and the feasibility of the project. Results showed that the farmers had to produce rubber latex as raw materials to process the rubber pale crepe. Though the nine-month actual operations were limited due to COVID pandemic time, the association processed an average of 387 kg/month dried rubber pale crepe and received an average income of P25,387.50/month. The product produced was with good quality as it passed the Philippine and ISO standards and the farmers' WTP was higher than the actual rate. Based on the feasibility study, the two scenarios of the project showed a promising financial indicator. Scenario 1 offers to buy rubber latex from the farmers, mill and dry the pale crepe for 4 days/week and custom milling only with a charge of P5/kg of crepe. This operation gave the association a positive NPV, BCR of P3.01, Payback period of 1.68 years and IRR of 54.18%. Scenario 2 extends custom rubber milling only at P5/kg of crepe rate which had a positive NPV, P3.15 BCR, within 1.61years the investments would be recouped and IRR of 56.79%.

**KEYWORDS:** Pale crepe, cup lump, rubber latex, rubber milling, custom rubber milling, willingness-to-pay, quality product.

## 1 INTRODUCTION

Rubber or *Hevea brasiliensis* has the largest plantation area in Kidapawan City with an approximate planting area of 4,000 hectares. It is the next important crop in Kidapawan next to coconut production. Farmers in the area commonly marketed rubber in the form of cup lump. Seventy percent (70%) or more of natural rubber processed and manufactured into tires (mostly for truck tires), off-road giant vehicles and aircraft tires [1]. However, there are vast products made of rubber in almost all types of industry, from transportation, food, medicine and even entertainment that can be explored by the local rubber industry [2].

At present, 80% of rubber trees planted on roughly 4,000 hectares are tappable [3]. Because of the very low buying price of rubber, many young and still unproductive rubber trees were top pruned to accommodate other crops such as banana lakatan, cacao, and other crops for added income. Rubber tappers stopped tapping due to the very low income they derived from cup lump that they could hardly support their families.

In developing further their rubber industry in spite of the unfavorable experience the city of Kidapawan had during the lowering of the price of rubber that started in 2014, the Kidapawan City Local Government Unit (LGU), emphasized that producing high quality natural rubber product in crepe or sheet form can increase the income from rubber production aside

from marketing in cup lump. Hence, a village type rubber latex processing plant is proposed by the LGU to showcase such rubber technology to the rubber farmers in the area.

## 2 MATERIALS AND METHODS

The study site was North Cotabato wherein the identified rubber plantations were located at Kidapawan City. The farmers' association *Kahugpungan sa mga Mag-uugma sa Singao* (KaMaSi) was pre-identified by the LGU of Kidapawan City to give a source of livelihood to the members.

For the financial profitability and acceptability of the rubber pale crepe processing system, a six-month operation led by the project team was conducted to showcase the technology with the potential operators of the cooperative as understudy. The team also assisted the officers of the cooperative in identifying target markets for the final product. This included gathering information on the requirements of the target markets and its prices offered.

Technical feasibility of the technology was based on its conversion rate, quality of raw materials, time and labor requirements, other inputs such as water, electricity, fuel, etc., the color, length and strength of the final product. Also, considered were the products' competitiveness in terms of price and quality as well as its marketing costs incurred.

As per its financial feasibility or viability, parameters used were the investment cost as against the processing costs and its best level of scale of operation that income would be realized by the cooperative. Feasibility studies with different scenarios were prepared for the reference of the potential users.

Technology acceptability was determined by the feedbacks gathered on the willingness to pay (WTP) for the technology by the members of the organization as well as other prospective users of the technology. This is the farmer's option price for the policy but for an individual who is risk averse and whose utility function depends only in income, expected surplus will underestimate option price for policies that reduce income risk and overestimate option price for policies that increase income risk [4]. A total of 79 respondents were interviewed; 39 members and 40 non-members.

In order for the members of the association to be more aware, knowledgeable and skilled about the technology, trainings were conducted.

## 3 RESULTS AND DISCUSSION

### 3.1 RUBBER CREPE PROCESSING MATERIALS AND SYSTEM

#### REQUIRED MACHINES AND EQUIPMENT

A processing system of producing rubber pale crepe was set up in KAMASI Association located in Singao, Kidapawan City. The rubber crepe machine was designed and developed by PHilMech while the other equipment such as the tubs and drying facilities were the existing facilities used in the area and the rest were readily available in the market (Table 1).

#### RAW MATERIALS

The most important raw material in the rubber pale crepe processing was the supply of rubber latex produced by the association and other farmers in the area. Sodium was the best anticoagulant for rubber crepe production. Clean water is required and formic acid as coagulant.

However, benchmark data showed that farmers in the area produced rubber cup lump, so a series of information dissemination on latex production to the farmers in the area was conducted to produce a first-class rubber crepe. There would be a change in the farm activities of the farmers because instead of harvesting cup lump twice a month, latex production required to harvest thrice a week. This posed a problem on performing their usual non-farm and other livelihood activities.

*Table 1. List of rubber crepe processing facilities and equipment specifications, KaMaSi Association, Kidapawan City, Philippines, 2020*

| Facilities and equipment | No. of units | Specifications | Remarks |
|---|---|---|---|
| Rubber crepe machine | 1 | Power supply: 8 HP single Cylinder Diesel Engine, Dimension: L=1778mm W=1511.3mm H = 1325.86mm Weight = 467kg | |
| Building | 1 | 6m x 15m | A complete set up is located in KAMASI Association |
| Tubs | 4 | 1m x 2.5m | |
| Drying facility | 1 | 3m x 6m | |
| Water system | 1 | | |
| Mechanical weighing scale | 1 | 100kg capacity | |
| Plastic pallet | 6 | 1m x 1m | |

**POSTHARVEST PROCESSING SYSTEM**

Rubber pale crepe processing comprises 6 steps. Figure 1 showed the different steps in the processing system. This was also in accordance with the Philippine National Standards on natural rubber code of practice (COP) – Good Agricultural Practice (GAP) or PNS/BAFS 286: 2023 [5] which supersedes the PNS/BAFPS 286: 2019.

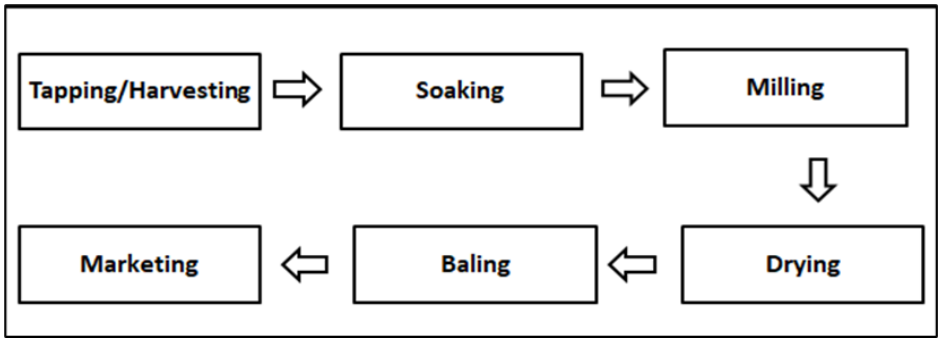


*Fig. 1. Process flow of rubber crepe production, Kidapawan City, North Cotabato, Philippines, 2020*

**TAPPING**

Tapping is usually done at dawn or early in the morning. Density and consistency of latex varies according to climatic conditions and time of tapping. Early morning tapping is said to have an increased productivity and a premium quality latex harvest with substantial reduction in the percentage of coagulum. Collected latex was stored in a plastic drum and transported to the processing site by means of a tricycle. Initially, farmers added sodium to the liquid latex to avoid improper coagulation.

*Fig. 2. Rubber tapping, KaMaSi Association, Kidapawan City, North Cotabato,*

*Philippines, 2020*

#### SOAKING

In the preparation of coagulum, formic acid is the most preferred and commonly used coagulant to manufacture rubber crepe. This method was adapted from the practice of the past rubber crepe processing center operating in Kidapawan City (Figure 3).

Sodium and formic acid were needed for proper coagulation of the latex. Initially, sodium was added to the liquid latex to avoid improper coagulation. For sodium, the ratio used on the solution was 2 tablespoon of powder sodium to 4 liters of water. While for formic acid, 75 ml of formic acid to 3 liters of water were mixed for the solution.

At the processing center, treatment was done on the concrete tub containing more or less 70 liters of water prior to the pouring of latex amounting to 70-100kg. An additional of 2 liters of sodium/water solution were mixed per tub. Formic acid/water solution of about 4 liters were added and mixed thoroughly to the same tub of latex to be processed. The average time of coagulation of rubber latex was 2 hours after thorough mixing based on the testing period. Coagulation was considered done if the bottom part of the coagulated block of latex was already firm and the water should be clear as much as possible.

After removing the coagulated latex for milling, the formic acid/water solution in the tub was discharged to the ground.

***Fig. 3. Adding formic acid, soaking and mixing, collecting coagulated block of latex, KaMaSi Association, Kidapawan City, North Cotabato, Philippines, 2020***

#### MILLING

Coagulated latex was shredded by hand into smaller pieces to easily process by the rubber crepe machine. Based on the testing period, the appropriate speed of operation was 15 rpm. This setting of spindle speed operation maximized the use of fuel. Engine rpm should be 1,680 rpm to obtain 15 rpm spindle speed. For the duration of consecutive testing, the average machine actual field capacity was 153.04 kg/hr. Rubber crepe processing requires at least one machine operator and one laborer (Figure 4a).

During milling, running water was supplied simultaneously with the milling of the coagulated latex to wash out the formic acid while the water flowed down to the soil.

#### DRYING

Right after milling, air drying of rubber crepes were done by hanging them in the drying area. Drying was usually done for two to three days. If drying was not done properly, rubber sheets would be of lower grade (Figure 4b).

#### BALING

After drying, collection of dried rubber crepe from the drying facility was done. The baling process is folding and weighing the rubber crepes and tying it with a plastic twine. Ready for marketing baled rubber crepe weighed around 20kg (Figure 4c).

*Fig. 4. Milling (a), drying (b) and baling rubber crepe (c), KaMaSi Association, Kidapawan City, North Cotabato, Philippines, 2020*

### 3.2 Rubber Crepe Processing Operations

Results of the rubber crepe processing pilot testing conducted showed that the average machine actual field capacity was 150 kg/hr latex. The total capacity of the machine was 1,200kg latex per day for 8 hours. For the soaking procedure, average time of coagulation of rubber latex was 2 hours after thorough mixing. Furthermore, the average wet weight basis recovery of the rubber crepe machine was 38.89% of the total latex weight. On the other hand, dry weight basis was 21.59% of the total latex weight. Drying process lasts for 2-3 days depending on the weather.

Table 2 shows the actual rubber crepe machine operations of the KaMaSi Association from October 2020 to August 2021. An average of 1,409.16 kg of latex per month were processed and produced a total of 3,482.09 kg of dried crepe with a 27.93% monthly average rate recovery from latex. No operations done in the months of April and May because of wintering period or the lean months for rubber production.

*Table 2. Actual rubber crepe processing, KaMaSi Association, Kidapawan City, North Cotabato, Philippines, October 2020 to August 2021*

| Month | No. of Processing Operations | Volume of Latex (kg) | Produced Dried Rubber Crepe (kg) | Average Percentage Recovery |
|---|---|---|---|---|
| 2020 | | | | |
| October | 6 | 300.25 | 78.02 | 25.99 |
| November | 17 | 1,476.85 | 396.93 | 26.88 |
| December | 29 | 3,114.00 | 685.76 | 22.02 |
| 2021 | | | | |
| January | 18 | 1,589.80 | 381.10 | 23.97 |
| February | 13 | 1,028.80 | 272.25 | 26.46 |
| March | 18 | 748.25 | 188.50 | 25.19 |
| June | 20 | 988.90 | 329.41 | 33.31 |
| July | 29 | 1,496.80 | 509.22 | 34.02 |
| August | 28 | 1,938.81 | 640.90 | 33.56 |
| Total | 178 | 12,682.46 | 3,482.09 | 27.46 |
| Monthly Average | 20 | 1,409.16 | 386.90 | 27.46 |

In spite of the series of information dissemination and training on the collection of latex, it was noted that the association was not able to accumulate enough supply of latex needed so as to achieve the machine's maximum actual field capacity. This was because the farmers were used to produce cup lump so that producing and collecting rubber latex every other day instead of twice a month was quite laborious for them. More so, farmers had assured market for cup lumps with the presence of the organized and administered several *bagsakan* or consolidation areas of the provincial government of North Cotabato in the province.

### 3.3 Quality Of The Rubber Crepe Produced

The Philippine National Standards (PNS) 203: 2013 [6] had set the guidelines for the grading and specifications of rubber. This was in reference to the ISO 2000: 2014 [7].

The KaMaSi submitted 12 samples to the Philippine Rubber Testing Center in the University of Southern Mindanao Institute to test the quality of the rubber crepe produced by the village-processing center. Parameters tested were dirt, initial wallace plasticity, plasticity retention index, nitrogen, volatile matter, ash and mooney viscosity. Results showed that the crepe produced by the association passed the ISO standards parameters meaning the product was with good quality (Table 3). More so, this showed that the product of the KaMaSi falls under the pale crepe category used as raw materials for the pharmaceutical materials and equipment and warrant to demand a higher price than the rubber crumb product.

Moreover, the differences in the international price of the pale crepe used for pharmaceutical materials and the rubber crumb used as raw material for tire manufacturing and other products was around $1.36/kg (Google.com).

***Table 3. Rubber crepe quality test results compared to the ISO grade standard, KaMaSi Association, Kidapawan City, North Cotabato, Philippines, 2022***

| Parameters of Analysis | Test Results* (12 samples from KaMaSi) | Grade Standard (ISO 2000:2014) |
|---|---|---|
| Dirt retained on the sieve maximum % (mass fraction) | 0.031 *(0.012 – 0.062)* | 0.05 – 0.20 |
| Initial Wallace plasticity ($P_0$) minimum | 39.22 *(34.2 – 46.10)* | 30 |
| Plasticity Retention Index (PRI) minimum | 78.27 *(68.9 – 81.80)* | 50 |
| Nitrogen content maximum % (mass fraction) | 0.21 *(0.17 – 0.30)* | 0.60 |
| Volatile matter content maximum % (mass fraction) | 0.72 *(0.62 – 0.97)* | 0.80 |
| Ash maximum % (mass fraction) | 0.20 *(0.19 – 0.22)* | 0.75 |
| Mooney Viscosity ML (1+4) at $100^0$C | 60.17 *(54.0 – 63.00)* | 65.00 |

** Philippine Rubber Testing Center, University of Southern Mindanao*

### 3.4 MARKETING OF RUBBER CREPE

During the piloting of the rubber crepe processing system, no other processor was producing rubber crepe in the area. With no information gathered on the market outlets from the identified processor before, the project staff scouted for potential markets for the rubber pale crepe produced. Identified markets were the existing buyers of rubber crumb in the area who showed interest on the product after showing a sample of the pale crepe product of the processing plant and offered a price a little bit higher than the rubber crumb.

The association decided to store the accumulated crepe and wait for a good price, thus in the nine-month pilot operations they only marketed twice. So far, they got a price at P75 and P78 per kg of crepe with total sales of P228,487.50. The first disposal was after six months of operation accumulating around 1,985.70 kg of crepe and after 3 months with around 1,020 kg. Considering the total 3,005.70 kg of crepe in the 9 months, the association was able to process an average of 333.97 kg of crepe per month and monthly average income of around P25,387.50 (Table 4).

***Table 4. Total sales of KaMaSi Association, Kidapawan City, North Cotabato, Philippines, October 2020 – August 11, 2021 Output***

| Date | Market outlets | Volume (kg) | Price/kg | Sales (P) |
|---|---|---|---|---|
| May 28, 2021 | Davao City Market outlet 1 | 1,985.70 | 75 | 148,927.50 |
| August 18, 2021 | Davao City Market outlet 2 | 1,020 | 78 | 79,560 |
| | **TOTAL** | **3,005.70** | | **228,487.50** |
| | **Monthly Average** | **333.97** | | **25,387.50** |

### 3.5 Willingness To Pay Of Farmers For The Rubber Crepe Custom Milling

Since this processing center was a showcase for the rubber farmers in the area, interviews were conducted on their willingness to pay (WTP) for the rubber crepe technology. They were asked if how much they were willing to pay for a kilogram of milled wet rubber crepe. There were 79 respondents. Out of 79 respondents, 39 farmers are members of KaMaSi Association while the other 40 farmers are non-members. Results showed that the average amount of rubber farmers' WTP per kilogram of wet rubber crepe was P5 (Table 5).

Comparing the above WTP to the actual expenses of milling per kilogram of wet rubber crepe shows that the association needs to collect more or less P5/kg of wet rubber crepe in order to gain profit in their milling services that was lower than the result of the farmer survey (Table 6).

***Table 5. Rubber farmers' willingness to pay for rubber crepe custom milling, KaMaSi, Kidapawan City, North Cotabato, Philippines, 2021***

| Custom Milling Fee (Wet Crepe) | Member | Non-Member | Total | Percentage (%) |
|---|---|---|---|---|
| P4/kg | 12 | 7 | 19 | 24.05 |
| P5/kg | 20 | 31 | 51 | 64.56 |
| P6/kg | 2 | 1 | 3 | 3.80 |
| P7/kg | 5 | 1 | 6 | 7.59 |
| **Total** | **39** | **40** | **79** | **100** |

*Source: Survey Note: 1USD=P55.00*

***Table 6. Rubber crepe machine's milling expense, KaMaSi, Kidapawan City, North Cotabato, Philippines, 2021 P/kg***

| Milling Expenses | ₱/kg |
|---|---|
| Fuel | 0.05 |
| Formic Acid | 0.5 |
| Labor | 1.5 |
| Water | 1.17 |
| Machine Maintenance | 0.06 |
| Miscellaneous Fee (2%) | 0.07 |
| **TOTAL** | **3.36** |
| plus 40% mark-up price | 1.34 |
| **Milling Fee/kg** | **4.70** |

*Note: 1USD=P55.00*

### 3.6 Feasibility Study Of A Village Level Rubber Crepe Primary Processing System

Feasibility study was conducted to determine the viability of the study. Data used in the feasibility study were all assumptions based from the actual processing during the nine-month operations. During the processing, the project team gathered the data needed used as basis for the feasibility study such as the labor, transport, packaging costs, formic acid and water usages, and other necessary data.

Two set ups were considered for the feasibility study; 1) rubber crepe machine and land costs were disregard from the investment costs because the machine was granted by DA-PhilMech and the land area for the processing site was donated by one of the members of KaMaSi Association and 2) the association purchased the rubber crepe machine.

Two feasibility study scenarios of rubber crepe processing were presented below that can be used as a guide of KaMaSi Association in order to gain the maximum profit that can generate from the rubber crepe machine.

#### Scenario 1

The association's rubber crepe processing will operate six times a week at 1,200kg latex per processing according to the rubber crepe machine's full processing capacity. The association would buy farmers' rubber latex at P17/kg and process it into rubber crepe for the first four days. While the next two days, the association would be extending milling services that offers

P5/kg of wet crepe as milling fee only while drying and marketing of the produced rubber crepe will be the farmers' responsibility because the drying area could only accommodate the first 4-day production.

Table 7 shows that the investment was around P301,000 which comprises the building, water system, mechanical weighing scale and the pallet. The operating costs worth P827,239.81 comprised 2.81 percent of fixed costs and 97.19 percent of variable costs. The expected gross income in the first year registered at P991, 872 and a net income of P164,632.19. The total investment would be recouped within 1.68 years, the project would have a BCR of P3.01 which was economically attractive, while it could manage to operate up to an interest rate of 54.19 percent and a positive NPV means that the project is expected to add value to the enterprise. Moreover, operating the plant four times a week, breakeven point volume and price for the rubber crepe was around 7,421.37kg and P75.38 at 1kg rubber crepe, respectively. Meanwhile, for the service milling two times a week, breakeven point volume and price for the wet rubber crepe were at 5,851.46kg and P4.83 at 1kg wet rubber crepe, respectively.

Based on the rubber crepe quality test results done by the Philippine rubber testing center in University of Southern Mindanao, product of the association is with high-quality that they could demand for a higher price.

#### SCENARIO 2

Unlike in Scenario 1 that income came from trading and services activities, the association's profit in this scenario would come from custom milling services alone. The operation would be six times a week milling services at 1,200kg latex per processing. Farmers would supply rubber latex to be processed by the association and pay P5/kg of wet crepe as milling fee to the association. The rubber farmers would be responsible for the drying and marketing of their rubber crepe.

Since the operation offers only custom rubber milling, the total operating costs is around P535,592.29. Out of this operating cost, fixed cost and variable cost is around 4.35% and 95.65%, respectively. The income from the custom milling fee at P5 per kg is expected to have a gross income in the first year of P708,480 and a net income of P172,887.71. The total investment (rubber milling machine as grant) would be recouped within 1.61 years, the project would have a BCR of P3.15 which was economically attractive, while it could manage to operate up to an interest rate of 56.79 percent and a positive NPV means that the project is viable. Furthermore, milling services breakeven point volume for milling crepe is at 16,815.63 and breakeven price for the milling is at P3.78 per kg.

#### SENSITIVITY ANALYSIS

Sensitivity analysis was done to determine how changes in price and volume variables affect the operation and business profitability of the village level rubber crepe processing center. All scenarios were very sensitive in the changes in price wherein at 10% decrease in price for the rubber crepe the association would experience losses in their operations.

*Table 7. Investment analysis of Village-Level Rubber crepe processing system, KaMaSi Association, Singao, Kidapawan City, North Cotabato, 2021*

| Item | Scenario 1 Latex + Milling | Scenario 2 Milling |
|---|---|---|
| Investment Cost, P | 301,000.00 | 301,000.00 |
| Fixed Cost, P | 23,280.00 | 23,280.00 |
| Depreciation | 12,790.00 | 12,790.00 |
| Repair & Maintenance | 4,470.00 | 4,470.00 |
| Registration & Licenses | 6,020.00 | 6,020.00 |
| Variable Cost, P | 803,959.81 | 512,312.29 |
| Salaries and Wages | 324,000.00 | 222,000.00 |
| Labor Handling | 311,780.00 | 205,920.00 |
| Fuel and Oil | 88,103.81 | 8,183.61 |
| Packaging materials | 3,900.00 | - |
| Formic Acid | 69,020.00 | 69,020.00 |
| Water Bill | 7,176.00 | 7,188.48 |
| Total Operating Cost, P | 827,239.81 | 535,592.29 |
| Latex buying price, P/kg | 17.00 | - |
| Crepe Selling price, P/kg | 78.00 | - |
| Rubber Milling fee, P/kg | 5.00 | 5.00 |
| Gross Income, P | 991,872.00 | 708,480.00 |
| Net Income, first year, P | 164,632.19 | 172,887.71 |
| Payback period, year | 1.68 | 1.61 |
| Internal Rate of Return, % | 54.18 | 56.79 |
| Benefit Cost Ratio, P | 3.01 | 3.15 |
| Net Present Value, P | 603,558.98 | 647,928.16 |
| Breakeven point volume | | |
| Dried crepe, kg | 7,421.37 | - |
| Milling, kg | 5,851.48 | 16,815.63 |
| Breakeven point price | | |
| Dried crepe, P | 75.38 | - |
| Milling fee, P | 4.83 | 3.78 |

*Note: 1USD=P55.00*

## 4 CONCLUSION

A village-level rubber pale crepe processing system for the farmers in Kidapawan City is feasible if the association would process around 1,200kg of rubber latex per month and received the right price for the product. The LGU and association should conduct more awareness and trainings on the production of rubber latex and the profitability of rubber crepe production to farmers so that they have an option what to produce between cup lump or latex. More so, encourage traders to open a market for rubber pale crepe in the area so that the product would receive its right price to compensate the farmers for producing rubber latex instead of cup lump.

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