# FEASIBILITY STUDY OF TUBER FLOUR FACTORY USING IN PACK CURING OR MODIFIED TUBER FLOUR (MOTUF) TO SUPPORT FOOD DIVERSIFICATION

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# FEASIBILITY STUDY OF TUBER FLOUR FACTORY USING IN PACK CURING OR MODIFIED TUBER FLOUR (MOTUF) TO SUPPORT FOOD DIVERSIFICATION

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## ABSTRACT

Recently, modified cassava flour has been successfully commercialized. On the other hand, other tubers such as Canna, arrowroot, and Dioscorea sp. are still underutilized. Several researchers had developed final products including noodle, muffin, bread, keroopok, etc. Such food products require steady tuber flour supplies by which flour factory plays important roles. The study aimed at investigating the feasibility of producing tuber flour from Canna, Dioscorea sp., arrowroot, and cassava tubers either using in pack curing in a polypropylene bag plus lime stone and then ground or parboiling-fermenting fresh tuber using Rhizopus sp. and lactic acid bacteria "Bimo". Experiments were run in a nested experimental design for developing technologies at laboratory scales followed by plant design based on the laboratory data analyzed using a linear method to determining Break Event Point (BEP). Results showed that fully mechanized factory was not feasible. The flour yields reached ca 20% limited to arrowroot and cassava tubers whereas *Dioscorea hispida*, canna, purple *Dioscorea alata*, and *Dioscorea esculenta* L. ranged from 5.47 to 8.76%. The economic analyses showed that BEP would be feasible when the production capacity were 19,000-40,000 kg of flour per year for all tubers either using in pack curing or MoTuF technology. Therefore, the factory should processes ≥263 kg of tubers a day and its selling cost at IDR 31,514–63,000/kg is much higher compared to that of currently available flour in the market. Building a proper agro-industrial infrastructure would succeed food diversification programs. In 2012 the demands of tuber flour in East Java Province were 1,310,944.458 tons and supplies are only 691,981.748 tons/year. Bangkalan with tuber productivity of 75.986 tons is one of potential suppliers to be. In conclusion, it is recommended to establish on farm tuber factory in Bangkalan to improve supply chain for tuber products and to support diversification program.

**Keywords:** feasibility of tuber flour factory, break event point, in pack curing, modified tuber flour

## INTRODUCTION

Food security is one of strategic points, which has long term impact on livelihood and societal development. It is indicated by adequate level of food accessibility and availability both quantitatively and qualitatively for the society members. Food processing and technology facilitates tools to secure the food adequacy for the society needs.

Efforts to develop food technology are necessarily complementary with economic feasibility analyses in order to determine effectiveness and efficiency of the technology being developed when the technology finally adopted for commercialization. Moreover, small and medium scale enterprises in Indonesia nowadays need supports on feasibility data of its factory or entity while it is running in the global economic issues, especially those working on food productions.

The development of food technology and processing either developing food raw materials or processed foods both producing intermediate and final products, provides prosperous businesses. This is because foods are human basic needs partly to gain well being and welfare. Currently, industry which processes agricultural produces, in particular food commodities, growing fast and making money well from economic added values to fulfil the demands in markets. In addition, the changes of life style in current era are concomitant with the increased buying power of the society.

A success story of cassava conservation into a commodity with bright added values through modified cassava flour (MoCaF) technology suggests the important role of food processing and technology in improving society welfare. Publications on MoCaF are continuously growing and proving that the flour is comparable to wheat flour in bakery and manufacturing various food products for food diversifications. There are many other types of tubers still kept being cultivated by farmers in Indonesia but these tubers have not been optimally utilized. In facts, there have been a lot of research developing such tubers into food products including noodle, muffin, bread/bakery, keroopok, by which stable tuber flour supplies are critically required. Hence, producers of flours other than cassava flour play important roles to fulfil the flour demand in order to support such food diversification. Data show that demands of the tuber flours in East Java Province reach 1,310,944.458 tons yet only supplied in the market around 691,981.748 tons/year. Bangkalan Town, where the research location is, has tuber productivity about 75,986 tons is one of potential flour suppliers required to support food diversification.

Prospective alternative technology proposed in the present study is in pack curing technology and modified tuber flour (MoTuF). The tuber flour then called MoTuF to distinguish it from MoCaF, which is recently well established and commercialized in a better standardized production system. The present research is aiming at conducting a feasibility study if the MoTuF and in pack curing technologies are established industrially. The selected tuber types are canna, arrowroot, and Dioscorea sp tubers.

### Simulation of laboratory works using MoCaF

The laboratory works for MoCaF were using 2 kg of peel free sliced-cassava tubers fermented by *Rhizopus oryzae* FNCC 6011. Machines used were home industry scales at Food Processing Laboratory, Widya Mandala Surabaya Catholic University. All costs were calculated at cost/on bill of the experiments and were simulated for a factory plan working at production capacity of 650 kg of unpeeled Adira cassava tubers employed 20 employees, working 8 hours/day established in Ponorogo Town, East Java. The plant is a full mechanized operating production system using peeling machine, parboiling tank, washer, slicer, drier, and packing machines. The laboratory works showed final flour yield was 19.07% of peeled tubers for the best parboiling time. Any legal aspects involved in the setting up of the factory follow Indonesian government regulation including wage system, taxes, labour protections, and environmental safety aspects.

The factory plan was studied for BEP and Minimum Attractive Rate of Return (MARR) methods and complementary return rate and payout period calculated according to Peter & Timmerhaus (1991). BEP is an analytical method to estimate minimum production with lower risk of bankruptcy. In the present research, BEP is calculated using equation developed by Peter & Timmerhaus (1991): BEP = (FC-0.3SVC)/(SC-0.7SVC-VC)*

Additional parameters to determine how the plant's performance would be are (1) MARR= interest rate + risk factor, (2) Pay out Period = [TCI/(depreciation + net profits)] x 1 year, and (3) Rate of Return = (net profits/TCI) x100%.

Following data of economic analyses are for the simulation of MoCaF factory which is producing product unit of 5 kg flour/pack.

**Fixed Capital Investment/FCI**

1. Direct Cost/DC: machine and equipments, installation, building and land, other facilities and services IDR 1,623,232,875.
2. Indirect Cost/IC: technicians, supervision, and construction IDR 168,601,125

FCI=DC+IC+contractor cost (3%)+safety factor (10%) = IDR 2,024,772,420

**Working Capital Investment/WCI**: raw materials, packing materials, utility, safety factor (5%) per month = IDR 76,878,428.12

**Total Capital Investment/TCI**

TCI = FCI + WCI
= IDR 2,024,772,420.00 + 76,878,428.12
= IDR 2,101,650,848.12

**Manufacturing Cost/MC**

1. Direct Production Cost/DPC: raw materials, packing materials, labours, utility, maintenance = IDR 1,130,560,914.78
2. Fixed Cost/FC for production: depreciation 10% of machines, 5% of building, and 1% of FCI for insurance = IDR 95,452,474.00
3. Plant Overhead Cost = 50% (labours + maintenance)

= 50% (IDR 396,000,000.00 + 60,355,899.00) = IDR 228,177,949.50

MC = DPC + FC + POC
= IDR 1,130,560,914.78 + 95,452,474.00+ 228,177,949.50
= IDR 1,454,384,975.28

**General Expense/GE:** administration and distribution/marketing = 5% TPC

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* FC=Fixed Cost, SVC=Semi variable cost, VC=variable cost, SC=Selling price per unit

= IDR 76,546,577.65

**Total Production Cost/TPC**

TPC= MC + GE= IDR 1,530,931,522.93

**Product sale cost:** 21 units/day x 6552 units x 0.85 sold x IDR 315,000

=IDR 1,754,235,000

## Economic analysis using BEP linear method

sale cost/year = IDR 1,754,235,000.00

total production cost/year = IDR 167,845,204.80

gross profits/year = IDR 1,586,389,795.20

Tax (Indonesian Tax Directorate General, 2010): 25% x IDR 1,586,389,795.20

= IDR 396,597,448.80

net profits/year = gross profits – taxes = IDR 1,586,389,795.20–396,597,448.80

= IDR 1,189,792,346.40

**Break Event Point /BEP**

1. Fixed Cost /FC = IDR 94,847,383.00
2. Semi Variable Cost /SVC: employees, maintenance, POC, GE, supplies = IDR 767,542,017.01
3. Variable Cost /VC: raw materials, packing materials, utility = IDR 667,743,424.92

$$\text{BEP} = \frac{\text{FC}+0.3\ \text{SVC}}{\text{SC}-0.7\text{SVC}-\text{VC}} \cdot 100\%$$

$$= \frac{94{,}847{,}383.00 + 0.3(767{,}542{,}017.01)}{1{,}754{,}235{,}000.00 - 0.7(767{,}542{,}017.01) - 667{,}743{,}424.92}\ x\ 100\%$$

$$= 59.20\ \%$$

**After tax Rate of Return/ROR =** (net profits/TCI) x100%

$$= \frac{\text{IDR } 1{,}189{,}792{,}346.40}{\text{IDR } 2{,}024{,}772{,}420.00}\ x\ 100\% \ = 58.76\%$$

To justify acceptable ROR is using MARR to indicate that the investment is more prosperous than depositing them in a bank.

**MARR**

Bank free risk rate = 7.4% (Mandiri Bank, 2014)

Risk factor = 10%

MARR= interest rate + risk factor = 17.4%

The ROR is much higher than MARR value indicating that the investment would be more beneficial when it is used to invest in the plant.

**After tax Payout Period/POP**

= [TCI/(depreciation + net profits)] x 1 year

$$= \frac{\text{IDR } 2{,}024{,}772{,}420.00}{\text{IDR } 75{,}204{,}750 + 1{,}189{,}792{,}346.40} \times 1 \text{ year}$$

= 1.60 ~ 1 year 7 months 6 days

BEP of 59.20% means that production capacity of Adira MoCaF would be giving equal total expenses to sale cost when the factory is run at 0.5920 x 650 kg of raw materials/processing cycle =365 kg of peeled cassava per day or equal to 608.33 kg of unpeeled cassava (depending on edible portion and moisture contents, for the best condition it is 263 kg of tubers/day) and the MoCaF should be sold at price of IDR 63,000/kg of flour. Nevertheless, it can reach payback time all investment if the factory is operating for 1.60 year or 1 year 7 months 6 days.

## Simulation of laboratory works using MoTuF and In Pack Curing

The simulation was based on laboratory works using 2 kg of tubers for all selected tubers (Dioscorea sp tubers, canna, and arrowroots) carried out at Food and Nutrition Research Centre and Food Processing Laboratory, Widya Mandala Surabaya Catholic University. The works applied a full mechanized production hiring three workers for washing and operating the machines. All machines are home industry scales. Based on the data a factory plan is set up in period term of 5 years to see how the operating plant predicted using BEP and NPV analyses for a more general factory establishment. Data laboratory showed efficiency of the yield was 4.04-18.83% of unpeeled tubers for MoTuF and 5.47-20.91% for in pack curing. The profiles of canna and Dioscore sp tubers were similar so they are grouped into the same calculation columns. The highest yield is for arrowroot, i.e. 12.72-23.14% and 17.14-20.91% for MoTuF and in pack curing, respectively. The yield is used as calculation basis in the simulation.

Production cost is an important parameter because the total amount of production costs will economically determine the economical values of the products. The higher the costs should be spent, the higher is the economic value of the products. The increased production cost certainly affects profitability and incomes which can be achieved by the entity/company. COGS (Cost of Goods Sold) approach is used for considering production cost structures. COGS is calculated using a full costing method because this method accounts all aspects involved in production costs as well as nonproduction cost. Finally, COGS is one of information required for determination of selling cost of the products.

In the present research COGS is applied to determine selling cost of the flours produced either using in pack curing technology or MoTuF. The selling cost comprises of 85% of COGS plus selling margin at 15%. The basis of margin is general bank interest of credits in 2014. Thus, if farmers take bank loan then the selected margin already covers up the responsibility to pay the loan when the products have been sold out.

The evaluation of economical feasibility in the present research is done in consideration of economic added values would be obtained if famers sell tuber flours instead of unprocessed tubers. The evaluation is indicated by feasibility parameters of Payback Period and Net Present Value (NPV). Payback period is useful in estimating time for farmers to get the equal values of investment invested in the past (beginning of the project). NPV gives information of investment feasibility in the project of conserving tubers into tuber flours. Any costs considered in the evaluation of enterprises feasibility are categorized into cash flow at the beginning of the project and ongoing cash flow (Ross, Westerfield & Jaffe, 2003).

### Initial Cash Flow

Initial cash flow is the first investment cost spent at the beginning of project. The cash flow meant in the present research is any expenses to prepare facilities for processing the tubers into tuber flour ultimately building, machinery and equipment, as well as any expenses for long term uses. The expenses include facilities for production of MoTuF and tuber flour from tubers treated with in pack curing technology (Table 1).

### Operational Cash Flow

Operational cost is defined as any relevant costs which directly involve in tuber processing into tuber flours. The operational costs of MoTuF and application of in pack curing prior to milling processes of the selected tubers in the present research for Arrowroot and canna/Dioscorea sp tubers are displayed in the Table 2. Based on COGS and a margin of 15%, the price of arrowroot flour is IDR 36,300/kg and canna/Dioscorea sp flour IDR 71,400/kg. The results are presented in Table 3 assuming 100 kg of tubers are processed working for 100 days/year due to seasonal period, fully mechanized plant, and employed 8 workers.

Table 1: Initial Cash Flow for MoTuF and in pack curing technology

| Item | values (IDR x 1000) | |
|---|---|---|
| | MoTuF | in pack curing |
| Building and its accessories | 2,500 | 110,000 |
| Machines and equipments, economic utility ≥5 years | 855,000 | 718,600 |
| Machines and equipments, economic utility ≤3 years | 9,900 | 21,775 |

Based on Table 3, it implies that tuber processing into tuber flour using five selected tubers in the present research would achieve BEP using MoTuF method when the factory produces minimum 38,381 kg of arrowroot flour or 19,055 kg of canna/Dioscorea flour per year. Table 4 tells us that the factory producing tuber flour using MoTuF method would be at its BEP when the factory produces at least 40,087 kg of arrowroot flour or 19,315 kg of canna/Dioscorea sp tuber flours.

Table 2: Cost Production

| Cost Items | Cost (IDR x 1000) | |
|---|---|---|
| | Arrowroot | Canna/Dioscorea |
| Direct cost | | |
| Raw materials (arrowroot): (100 kg/0.2) x IDR 5,000 x 100 days | 250,000 | |
| Raw materials canna/Dioscorea: (100 kg/0.09) x IDR 5,000 x 100 days | | 555,550 |
| Labour (5 x IDR 2,700,000 x 3 months) | 40,500 | 40,500 |
| Total | 290,500 | 596,050 |
| Indirect cost | | |
| Utility: water and electricity (IDR 200,000 x 3 months) | 600 | 600 |
| Permanent employees (3 x IDR 2,700,000 x 3 months) | 24,300 | 24,300 |
| Total | 24,900 | 24,900 |
| COGS | 315,400 | 620,950 |
| COGS per kg | | |
| Arrowroot: (IDR 325,400,000/(100 kg x 100 days) | 31.514/kg | |
| Canna/Dioscorea: (IDR 620,950/(100 kg x 100 days) | | 62.095/kg |
| Selling price with 15% margin | 36.300/kg | 71.400/kg |

Table 3: BEP for MoTuF technology

| Components | Calculation (x 1000) | Cost (x 1000) | |
|---|---|---|---|
| | | arrowroot | canna/Dioscorea |
| FC | IDR (110,000+855.000)/5 years | 171,022/year | 171.022/year |
| SVC | IDR 9,900/3 year/(100 kg x 100 days) | 0.330/kg | 0.330/kg |
| VC | IDR 315,400/(100 kg x 100 days) | 31.514/kg | |
| | IDR 620,950/(100 kg x100 days) | | 62.095/kg |
| SC | | 36.300/kg | 71.400/kg |
| BEP (kg) | 171,022/(36.300-0.330-31.514) | 38.381 | |
| | 171,022/(71.400-0.330-62.095) | | 19.055 |

Table 4: BEP metode in pack curing

| Components | Calculation (x 1000) | Cost (x1000) | |
|---|---|---|---|
| | | arrowroot | canna/Dioscorea |
| FC | IDR (110,000+718,600)/5 years | 165,720/year | 165,720/year |
| SVC | IDR 21,775/3 years/(100 kg x 100 days) | 0.725/kg | 0.725/kg |
| VC | IDR 315,400/(100 kg x 100 days) | 31.514/kg | |
| | IDR 620,950/(100 kg x 100 days) | | 62.095/kg |
| SC | | 36.300/kg | 71.400/kg |
| BEP (kg) | 165,720/(36.300-0.725-31.514) | 40.807 | |
| | 165,720/(71.400-0.725-62.095) | | 19.315 |

## Feasibility study using Net Present Value (NPV)

Determination of feasibility of a project can be done using NPV method. This method calculates the present value of cash flows in and out. In the present research cash flow is calculated based on the initial cash flow (at the beginning of the project) and operating cash flow. The procedure of determination of the NPV is following steps.

1. Determining initial cash flow, in the present research using data from tables above.
2. Determining cash flow of operating project, which considers periodical cash streams taking place in each production period. In the present research, the operating cash flow is calculated based on differences between sale costs and manufacturing costs.

If production capacity is 100 kg of tubers per day and the factory works for 100 days/year, operating cash flow would be:

a. arrowroot

(IDR 36,300 x 100 kg x 100 days)–(IDR 31,514 x 100 kg x 100 days)

= IDR 47,860,000

b. canna/Dioscorea sp

(IDR 71,400 x100 kg x 100 days)-(IDR 62,095 x 100 kg x 100 days)

= IDR 93,050,000

If sale cost increases by 5%/year, estimation of annual operating cash flow can be studied in Table 5 and 6 for MoTuF and flour treated with in pack curing from arrowroot and canna/Dioscrea sp, respectively. A factory/business is categorized as feasible to operate when its operation results in positive values of NPV i.e. cash inflow is higher than cash outflow at certain time intervals (in the present research is 5 years).

NPV can be calculated using the following equation: $\text{NPV}^{\dagger} = \sum_{t=1}^{n} \frac{NCF}{(1+i)^t}$

Observing data in Table 5, it can be seen that NPV is IDR (-732,402,506) for arrowroots. Interpretation of this data is that investment values on buildings and machineries is very high compared to the net incomes obtained. Therefore, the plant design targeted as fully mechanized for producing MoTuF is not feasible.

Table 6: Cash flow of factory producing MoTuF from canna/Dioscorea sp tubers

| Components | values (IDR x 1000) | | | | |
|---|---|---|---|---|---|
| | year 0 | 1 | 2 | 3 | 5 |
| Initial CF | (974,900) | - | - | (9,900) | |
| Operating CF | 93,050 | 107,007.50 | 112,357.875 | 17,975.769 | 130,068.285 |
| Net CF | (881,850) | 107,007.50 | 112,357.875 | 08,075.769 | 130,068.285 |
| NPV | | | (497,287.127) | | |

Similarly, the NPV for MoTuF method and the factory designed as a fully mechanized plant processes canna/Dioscorea sp tubers is IDR (-497,287,127) as shown in Table 6

† NCF: net cash flow, *i*: Discount rate, in the present research it is 15% in line with current interest rate of bank loans and n is working periods.

indicating that investment values for building and machinery/equipments is much higher than net profits obtained. Hence, the production of MoTuF for canna is not feasible in such plant design.

The NPV obtained for arrowroot and canna/Dioscorea sp flour using in pack curing method is IDR (-593,910,511) and IDR (-358,795,132), respectively (Table 7 and 8). Hence, the plant design to produce arrowroot flour using in pack curing method which is fully mechanized/equipment is not feasible to be operated.

Table 7: Cash flow of factory producing arrowroot flour in Pack Curing method

| components | values (IDR x 1000) | | | | |
|---|---|---|---|---|---|
| | year 0 | 1 | 2 | 3 | 5 |
| Initial CF | (828,600) | | | (21,775) | |
| Operating CF | 47,860 | 55,039 | 57,790.950 | 60,680.498 | 66,900.248 |
| Net CF | (780,740) | 55,039 | 57,790.950 | 38,905.498 | 66,900.248 |
| NPV | | | (593,910.511) | | |

Table 8: Cash flows of factory producing canna/Dioscorea flours using in Pack Curing

| Components | values (IDR x 1000) | | | | |
|---|---|---|---|---|---|
| | year 0 | 1 | 2 | 3 | 5 |
| Initial CF | (828,600) | | | (21,775) | |
| Operating CF | 93,050 | 107,007.50 | 112,357.875 | 117,975.769 | 130,068.285 |
| Net CF | (735,550) | 107,007.50 | 112,357.875 | 96,200.769 | 130,068.285 |
| NPV | | | (358,795.132) | | |

Nevertheless, in pack curing method has less initial cash flow IDR -828,600,000 than MoTuF (IDR -974,900,000) but higher than NPVs for all MoTuF.

## Evaluation of plant design feasibility

Overall data resulted from analyses in the present research is shown in Table 9 informing us that the economical feasibility of business unit involving fully mechanized plant design either for MoTuF or in pack curing quite comparable for canna/Dioscorea as well as for arrowroot. Arrowroot requires higher production capacity (38,381-40,087 kg of flour) than canna/Dioscorea sp (ca 19,500 kg flour).

Data analyses for arrowroot using either MoTuF or in pack curing to produce tuber flours result in COGS as much as IDR 31,514/kg. Thus, to obtain 1 kg arrowroot flour it costs IDR 31,514. Meanwhile, canna/Dioscorea sp tubers cost IDR 62,095. The difference of COGS is because conversion ratio of tuber to flour for canna/Dioscorea sp tubers is very small, i.e. maximum 0.09 kg flour/kg tubers. On the other hand, arrowroot could produce 0.2 kg flour/kg tubers. The conversion ratio is empiric data.

Analyses of BEP for MoTuF method show that the MoTuF factory processes arrowroot at least producing 38,381 kg of flour/year in order to stay profitable whereas canna/Dioscorea sp tubers minimum production should be 19,055 kg of flour/year. These estimations are quite similar to those of in pack curing method where minimum production is 40,087 kg of flour/year for arrowroot and 19,315 kg of flour/year for canna/Dioscorea sp tubers. More interestingly, the numbers for canna/Dioscorea flours are comparable to equivalence flours should be obtained from cassava (MoCaF) in the present research, i.e. ca 20,743 kg of flour/year.

Table 9: COGS, BEP and NPV for arrowroot and canna/Dioscorea sp flour manufacturing

| Methods | values | | | | | |
|---|---|---|---|---|---|---|
| | arrowroot | | | canna/Dioscorea | | |
| | COGS (IDR/kg) | BEP (kg) | NPV | COGS (IDR/kg) | BEP (kg) | NPV |
| MoTuF | 31,514 | 38,381 | (732,402,506) | 62,095 | 19,055 | (497,287,127) |
| In pack curing | 31,514 | 40,087 | (593,910,511) | 62,095 | 19,315 | (358,795,132) |

Data analyses use NPV method both for arrowroot or canna/Dioscorea sp tuber processing implementing MoTuF or in pack curing technology indicate negative NPVs. This suggests that investment taken for the plant for 5 years would have not been giving any financial profits. It is recommended to reduce the initial investment load (semi-mechanized production system) and to increase production capacity of the plant desired (for instance, instead of 100 kg of flour/day it is preferred 130 kg of flour/day equal to 650 kg tubers/day).

## CONCLUSION

The feasibility evaluation towards business planning of tuber flour has been done through research and simulation based on empirical works for Adira cassava, arrowroot, canna tubers, and Dioscorea sp. tubers. The first simulation is using Adira cassava to evaluate MoCaF as a more established commodity and also a success story for tuber flour developed. The simulation shows that production capacity of ca 650 kg unpeeled cassava fully mechanized (washing/cutting/drying/grinding/sieving/packing) is hardly feasible with very high sale cost (IDR 63,000/kg of MoCaF). Similarly, simulation using different economic evaluation results in canna/Dioscorea sp tubers sale cost of IDR 71,400/kg and for arrowroot IDR 36,300 with 15% margin applied for MoTuF and in pack curing, respectively. This means that production costs are IDR 31,514/kg and 62,095/kg. Evaluation of feasibility based on BEP for operating term 5 years if the factory processes the tubers according to MoTuF technology show that minimum production capacity is 38,381 kg of flour/year and 19,055 kg of flour/year for arrowroot and canna/Dioscorea sp. tubers, respectively. Meanwhile, it has minimum production for in pack curing using canna/Dioscorea sp tubers and arrowroot of 19,315 kg flour/year and 40,087 kg of flour/year, respectively. Only canna/Dioscorea sp production is comparable to that of MoCaF (ca 20,743 kg of flour/year). Such simulation yet gives negative NPVs because estimated cash inflow is lower than cash outflow so that the factory is not feasible to be operated in a fully mechanized factory both using in pack curing and MoTuF. It means that there would be no financial profits for 5 years operation, except for MoCaF with payout of period 1.6 years and production capacity of 650 kg tubers/day. The reason is more likely that cassava flour has been well applied in various industries. Re-evaluation of the investment is recommended in particular to change the factory into a semi-mechanized design. Laboratory simulation using Adira cassava found that the most expensive cost is electricity load for cabinet drying and water if wet lactic acid bacterial fermentation preferred. There still an opportunity to apply the technology to support food diversification program and ultimately to improve food quality, convenience, and to secure food supplies for canna/Dioscorea sp tubers. To improve the factory performance it is recommended that production capacity of the factory should be increased when farmers capable of cultivating the tubers in higher productivity scales, or to run factory in a semi-mechanized way.

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