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Adoption of Rootcrop and Fruit–Based Processing Technologies Learned from Training Programs

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Abstract

The Benguet State University-Northern Philippine Rootcrops Research and Training Center (BSU-NPRCRTC) has disseminated processing technologies to individual household members, farmers, and associations in communities in collaboration with regional line agencies in the Cordillera Administrative Region and Region I. Fourteen trainings were conducted that focused on rootcrop-based snack items, desserts, breads, cookies, and beverages. Flour making from cassava was also introduced. A total of 487 individuals and four associations were trained. Preliminary results showed that the technologies on making ube wine, instant ginger tea, instant turmeric tea, and potato chips were adopted as livelihood enterprises. The technologies on 'ube halaya', sweetpotato juice, 'puto', 'maja', camarind, cassava flour, starch, 'pitchi-pitchi', 'kutchinta', and 'bibingka' were adopted only for household consumption and special occasions. One association improved blot drying process in potato chips production, which increased their production efficiency. Production of ube wine generated the highest returns over cash expenses at 37.82%, followed by instant turmeric and ginger tea at 28.08% and 34.08%, respectively. Lack of market promotion and limited market are the major problems that constrained the adoption of the processing technologies.

KEYWORDS

BSU-NPRCRTC
root crop product
root crops processing
adoption

Introduction

To promote food self-sufficiency, Filipinos are encouraged to diversify their diet and include alternative rice staples such as rootcrops. The average total domestic rice production from 2016 to 2019 in terms of milled rice equivalent was 12.2 million metric tons, while the country's average total rice requirement in the same period is 13.58 million metric tons (Philippine Statistics Authority [PSA], 2019). To ease this excess demand for rice, the Philippine Department of Agriculture has been promoting the consumption of rootcrops.

Rootcrops are good substitute staples because it has low glycemic index (Trinidad et al., 2010). According to Coyle and Kuballa (2020), a diet with low glycemic index results in weight loss, reduces blood sugar levels and lowers the risk of heart disease and diabetes.

Nutritionally, root crops contain significant amounts of dietary fiber. Sweetpotato, for example depending on the variety, is rich in vitamins A, C, and minerals such as calcium. Orange and yellow-fleshed varieties are rich in β-carotene (Teow et al., 2007). Cassava and taro are good sources

of potassium (Chandrasekara & Kumar, 2016). Violet colored vegetables and rootcrops are high in antioxidant anthocyanin pigments (Khoo et al., 2017). Consuming a purple sweetpotato may prevent colon cancer by modulating antioxidant status (Lim et al., 2013). Hence, incorporating rootcrops in food products enhances their nutritional content and health benefits. It can be baked into or incorporated in bread and cookies, fermented into wine and vinegar, fried as chips, processed into candies and steamed either in fresh or flour form.

Institutions like the Department of Agriculture (DA), Department of Trade and Industry (DTI) and non-government institutions have been requesting trainings from the BSU-NPRCRTC on rootcrop processing. The general aim of these trainings is to create an avenue for more livelihood opportunities among households, out of school youth, farmers, and interested stakeholders of the place especially in the fifth class municipalities of the Cordillera Administrative Regions. According to Leach et al. (2001), if a training is well designed and delivered, it could lead to increased income, which could lead to improved self-esteem and in some cases improved status in the household and the community. Thus with trainings attended, knowledge on the utilization of rootcrops was increased, making it easier to decide by an individual or association to adopt the technology either for livelihood (means of living or additional income) or home consumption. As defined by Eneh (2010), technology adoption is a decision of individual or organization to utilize or implement a technology.

Specifically, the trainings aim to enhance the knowledge, skills, and sensitivity to quality of stakeholders in processing rootcrops. It also aimed to increase awareness of farmers, housewives, and technicians on the nutritional importance, utilization, and processing techniques. A developed training module included the nutritional benefits of consuming rootcrops and hands-on demonstration on the preparation of rootcrop food products. After the training, it is expected that the participants gained basic knowledge on rootcrop utilization either for home consumption or for livelihood. This study aimed to assess the technology adoption of rootcrop and fruit-based processing technologies. It identified technologies adopted by stakeholders either for home consumption or livelihood, estimated the profitability of adopting processing technologies and identified problems encountered in adopting the technologies.

Framework of the Study

Figure 1 presents the study framework detailing the issues addressed, expected impacts, the interventions, and the areas covered in the intervention assessment. The BSU-NPRCRTC project intervention, implemented in collaboration with different organizations, includes informal training covering rootcrops- and fruit-based processing recipes. This preliminary intervention assessment includes the extent of technology adoption, the profitability of technologies adopted, and the problems and constraints to adoption. The concept of adopting in this study means the trainee uses or modifies the processing recipe learned from the training for producing products either for home consumption or for livelihood.

Methodology

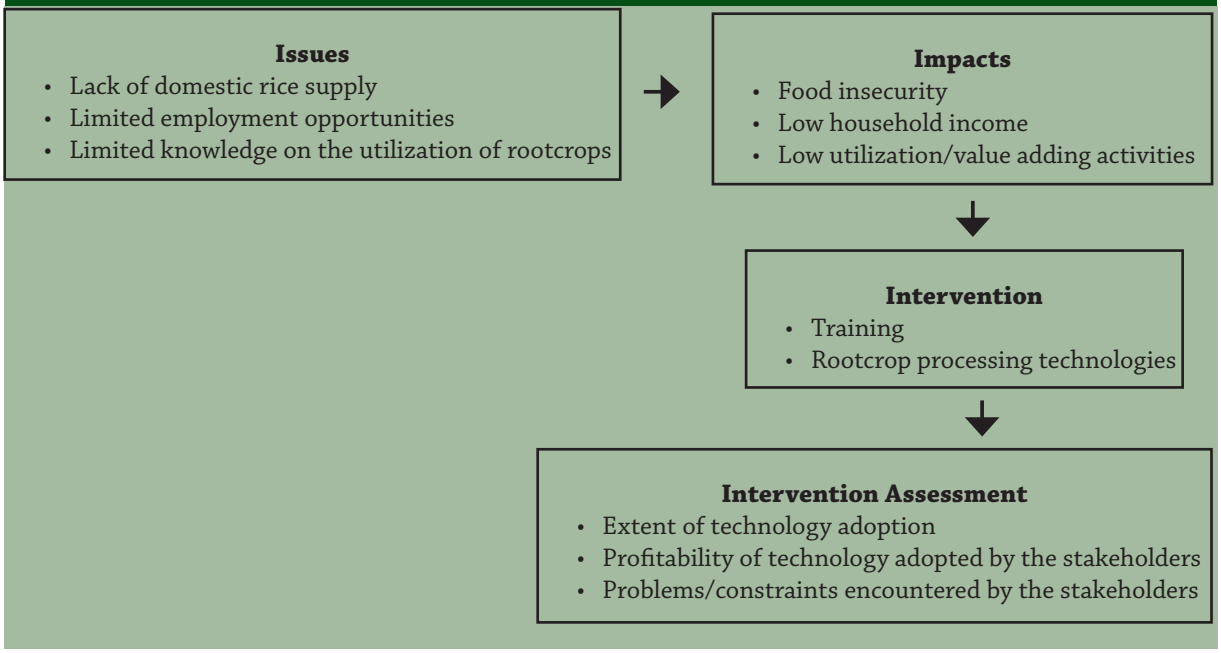
Of the 487 who attended the trainings on processing, 33 adopters from Ilocos Region, Benguet, and Mountain Province were interviewed—four associations with a total of 13 members and 20 individual respondents. The associations interviewed were Sugpon Food Processors Association with five members, Green Thumb 4-H Club with four members, Samantha's Livelihood with two members, and Taynan's Livelihood with two members. These associations were purposively selected from the list of associations where the topics on rootcrop and fruit-based processing technologies were included from the various trainings conducted by the NPRCRTC and the different line agencies.

Group interview was conducted for the associations, while face-to-face, one-on-one interview or cellphone interview were conducted for the individual adopters' depending on their situation and convenience. A semi-structured questionnaire was used as a guide in the interview. Data gathered were focused mainly on how the technologies were utilized, its profitability, and the problems encountered in adopting the technology.

The profitability was estimated based on the cost of ingredients, fuel, packaging material, labor,

Figure 1

Framework of the Study



and overhead cost, using the following return over cash expenses (ROCE) formula:

$$ROCE = \frac{\text{Gross sales - Cash expenses}}{\text{Cash expenses}} \times 100$$

Results and Discussion

Processing Technologies Disseminated or Promoted

Processing technologies disseminated/promoted included 39 rootcrop and fruit-based breads, cookies, candies, beverages, and condiments (Table 1). Technologies disseminated depended on the priority crop of the concerned agencies. The trainings conducted by the DA through the Agricultural Training Institute (ATI) and Cordillera Highland Agricultural Resource Management Project (CHARMP) were more concentrated on Cassava processing and utilization in Kapangan, Abra, and Kalinga (Figure 2). In Bauko, Mountain Province, the training was on potato processing. The training in Sugpon, Ilocos Sur was on the Municipality's main crops, such as ube and ginger (Figure 3). Banana processing into chips, catsup, patties, and vinegar were also introduced to the participants. The trainings conducted in Cervantes, Ilocos Sur, and Barlig, Mountain Province focused on ginger tea, concentrate, and candy processing (Figure 4).

Trainings Conducted

From 2010 to 2014, BSU-NPRCRTC conducted 13 trainings, all based on request by participants from various locations in the CAR, and Region 1 (Table 2). The participants who attended the trainings that were conducted at the NPRCRTC were representatives from the different municipalities of Benguet and Mountain Province. There were 487 participants, which were consisted of technicians (agriculturist and extension workers), homemakers, and farmers. In Sugpon, Ilocos Sur, the training was done with members of the Sugpon Food Processors Association (SFPA).

Partner agencies for these trainings aimed to increase awareness of housewives, farmers, and technicians on the nutritional importance and utilization techniques for rootcrop, and bananas. They encourage the participants to learn the basic processing techniques either for household consumption or for livelihood purposes.

Table 1

Technologies Disseminated through Trainings per Commodity in Benguet, Mountain Province, Abra, Kalinga, and the Ilocos Region

Commodity/ Technologies Disseminated	No.	BSU	Kapangan	Bauko	Barlig	Bontoc	Abra	Kalinga	Sugpon	Cervantes
POTATO chips; 'puto' 'Halaya'; Cranklet; Maja, siomai	6			Chips 'puto' Halaya' Cranklets Maja siomai						
SWEETPOTATO maja; meatloaf molido; bread muffins; juice chips; camarind	8	maja meatloaf molido bread muffins juice					bread muffins	bread muffins camarind		chips
CASSAVA grates & flour; 'pitchi-pitchi'; cookies; 'kutcinta' cacharon; 'bibingka' polvoron; twist fish balls; fish nuggets	10	grates & flour 'pitchi-pitchi' cookies 'kutcinta' cacharon 'bibingka' polvoron twist fish balls fish nuggets	grates & flour 'pitchi-pitchi' 'kutchinta' cacharon 'bibingka' polvoron twist fish balls fish nuggets		grates & flour 'pitchi-pitchi' 'kutchinta'	grates & flour starch	grates & flour 'pitchi-pitchi' cookies 'kutcinta' cacharon 'bibingka' polvoron twist fish balls fish nuggets	grates & flour 'pitchi-pitchi' cookies 'kutcinta' cacharon 'bibingka' polvoron twist fish balls fish nuggets		

Table 1 continuation...

Commodity/ Technologies Disseminated	No.	BSU	Kapangan	Bauko	Barlig	Bontoc	Abra	Kalinga	Sugpon	Cervantes
UBE 'halaya'; pastillas hopia; wine flour	5	'halaya' pastillas				'halaya' pastillas			'halaya' wine hopia flour pastillas	
GABI Pudding; chips	2	Pudding chips				chips				
GINGER Concentrate; Candy Tea; powder	4	concentrate candy tea, powder								Concentrate powder
BANANA Catsup; Vinegar Chips; paties	4	Catsup vinegar chips						cutsup paties chips		vinegar chips
Total no. of technologies	39									

Figure 2

Training on Cassava Processing and Utilization in Kapangan

Figure 3

Training on Ube and Ginger Processing in Sugpon

Figure 4

Training on Ginger Processing in Barlig, Mountain Province

Table 2

Type and Number of Client Served

Title of Trainings	Date & Venue	Participants	Number of Participants
1. Potato processing	Nov. 2010-Sayangan, Atok Jan. 2010-Bonglo, Atok Mar 15-16, 2011	4-H Club Cyndy Tanas Housewives, farmers	15 1 30
2. Cassava processing	July 11-12, 2012, NPRCRTC	Technicians, RICs	37
3. Training on gabi, yam, and sweetpotato processing	Aug. 27-28, 2012 NPRCRTC	Technicians, RICs	35
4. Banana processing	Dec. -9-12,2013, Dinwide, Cervantes	Housewives, farmers	25
5. Rootcrop processing	Dec 17-19,2012, NPRCRTC	Technicians, RICs	35
6. Ginger and guyabano processing	May 22, 2013, BSU College of Home Economics and Technology	ENDP women's group	25
7. Rootcrop and fruit processing	May 27-31, 2013, NPRCRTC	Technicians, RICs, housewives, farmers	37
8. Cassava production and processing	April 15-18,2013, Kalinga	Technicians, housewives, farmer	35
	July 29-30, 2013, Kapangan	Housewives, farmers	35
9. Rootcrop processing	Sept 9-11, 2013, NPRCRTC	Technicians, RIC's, housewives, farmers	35
10. Ginger and cassava processing	Sept 17-19, 2012, Natonin, Mountain Province	Housewives, farmers	27

Table 2 continuation...

Title of Trainings	Date & Venue	Participants	Number of Participants
11. Cassava production and postharvest technologies for Agricultural Extension Workers (AEWs) and farmers of 4th -6th class municipalities of Abra	Mar 5-7, 2014, Abra	AEWs, housewives, farmers	45
12. Skills training on food processing	Mar 26-27, 2014, Sugpon	Sugpon Food Processors Association	15
13. Training course on saba banana and rootcrop products processing, packaging & marketing for AEWs and farmers of selected municipalities in Kalinga	June 4-6, 2014, Kalinga	AEWs, RICs, farmers	55
Total number of participants			**487**

Technologies Adopted for Home Consumption and Livelihood

Of the 33 adopters interviewed, 20 individuals or 60.61% adopted 12 rootcrop-based processing technologies for home consumption and served during special occasions (Table 3). The adopted products include 'ube', potato, sweetpotato 'halaya', sweetpotato juice, 'puto' and maja, camarind, cassava flour, starch, 'pitci-pitchi', 'kutchinta' and 'bibingka' (Figure 5). These adopters are from the Ilocos Region (1), Benguet (16), and Mountain Province (3).

According to the adopters, these processing technologies disseminated are the easiest to prepare. They prepare these products for household consumption and serve them to visitors during special occasions like birthdays, child dedications, christmas party, and others because they consider the nutrients that they can get from the different rootcrops. These homemade products are much better than buying commercially processed products. Sweetpotatoes are the best sources of vitamin A for the orange-fleshed (Szaley, 2018) and high for anthocyanin for the purple-fleshed (Robbins, 2017); cassava is high in potassium (Montagnac et al., 2009).

Thirteen participants or 39.39% (Table 3) who belong to the different associations, adopted different processing technologies purposely as a source of livelihood or additional income. The individual households from these associations also produce for family consumption, prepared and served to visitors during family affairs like birthdays, child dedication, christmas party, and others. According to the participants, the processed rootcrops are more nutritious and that there is a value-added to the product. Another reason is that processing the crops would yield them higher income when their crop's price is low in the market. Their raw materials come from their own farm and co-farmers since it is their one town one product (OTOP). Ube wine, instant ginger tea, and turmeric tea (Figure 6) are the products adopted by the Sugpon Food Processors Association of Ilocos Region with five members while Green Thumb 4–H Club with four members, Samantha's and Taynan's livelihood of Benguet with 2 members each adopted potato chips (Figure 7; Table 4).

Technologies Adopted as Source of Livelihood and Years of Operation

Table 4 shows the number of years of operation and the technologies and products adopted by four (4) associations who adopted different processing technologies.

Sugpon Food Processors Association was formed in 2010 just after their training on ube processing. Ube wine was their first product. When they requested for another training on ginger

Table 3

Technologies Adopted for Home Consumption and Livelihood

Technologies Adopted	Provinces			Total
	Ilocos Region	Benguet	Mountain Province	
Individual adopters (n=20)				
Ube 'halaya'	1	1		2
SP juice, 'puto', maja, 'halaya'		2		2
Potato 'halaya'		6		6
Camarind		1		1
Cassava flour and starch			3	3
Cassava 'pitchi-pitchi', 'kutchinta', 'bibingka'		6		6
Associations (n=13)				
Ube wine, instant ginger, and turmeric tea	5			5
Potato chips		8		8
Total	6	24	3	33

Figure 5

Rootcrop-based Products Adopted by Respondents for Home Consumption

Figure 6

Sugpon Food Processors Association with their Products, Ube Wine and Ginger Tea

Figure 7

Green Thumb 4H Club, Samantha's and Taynan's with Potato Chips as their Product

Table 4

Processing Technology Adopters as Source of Livelihood and Years of Operation

Technology Adopters and Products	Years of Operation
Sugpon Food Processors Association (5 members) Ube wine, Instant ginger, and turmeric tea	2010 – present
Green thumb 4-H club (4 members), Potato chips	2010 – 2015
Samantha's Livelihood (2 members) Potato Chips	2010 – 2015
Taynan Family Livelihood (2 members) Potato chips	2016 – present

processing in 2011, ginger and turmeric tea were included in their product line. Their association is operating up to the present.

Green Thumb 4–H Club and Samantha's Livelihood started their potato processing in 2010 but stopped in 2015 due to uncollected debts and family problems. Taynan's Family Livelihood started in 2016.

Modifications Done on Adopted Technologies

For potato chips, Samantha's Livelihood modified the process of reducing the moisture before deep-frying in cooking oil. Instead of manually using a clean cloth to wipe or blot dry the chips, they successfully used spin dryer in wiping a greater volume of chips in less time (Figure 8). The procedure is to wrap the sliced or chipped potatoes with a clean white cotton cloth, then spin-dried for one minute. Using spin dryer, they can increase the volume of potato chips blot dried from five kilograms in three hours (if manual wiping) to 20 kilograms at one time using spin dryer. Thus, they can increase their production from 25 to 100 packs at 50g/pack per cycle due to the lesser time spent in blot drying the chips.

Sugpon Food Processors Association, Green Thumb 4-H, and Taynan's Livelihood did not modify the original process/procedure of the adopted products that were demonstrated to them during the training. According to them, they are already contented with what they learned. However, Green Thumb 4-H Club and Taynan's Livelihood followed the modification of Samantha's Livelihood using spin dryer to reduce potato moisture before deep-frying.

Figure 8

Spin-dryer being Used instead of Manual Blot-drying

Source of Capital, Frequency of Processing and Number of Packs Processed per Processing Schedule

Capital is necessary in starting a livelihood. Except for Samantha's Livelihood whose source of capital came from the Department of Science and Technology (DOST), the capital of the rest of the adapters came from the members' capital build-up with the financial assistance from the Local Government Unit (LGU).

The Sugpon Food Processors Association processes ube wine twice a month, while they process instant ginger tea and turmeric tea monthly. The Taynan's Family Association processed potato chips once or twice a month depending on the orders, while Green Thumb 4-H Club process potato chips only when there are trade fairs or orders.

The number of packs/bottles/jars produced per schedule of processing depends on the availability of raw materials. For Sugpon Food Processors, they process 50 to 100 bottles for ube wine (750ml/bottle) and 100 to 200 jars (125g/jar) for instant ginger tea, and turmeric tea. For potato chips, the number of packs processed by the Green Thumb 4–H club, Taynan's, and Samantha's Family Livelihood ranges from 50 to 200 packs per schedule (Table 5).

Production Cost and Estimated ROCE of Products Adopted

Table 6 presents the estimated production cost per unit, selling price and ROCE of the processed products made by the different associations. Based on record gathered from the Sugpon Food Processors Association with the following processed products namely: ube wine, ginger, and turmeric tea, which were processed by five persons in 11 days within the month, and with a computed ROCE ranging from 28 to 37%. For

Table 5

Source of Capital, Frequency of Processing and Number of Pack/s, Bottles Processed per Schedule

Products of Adopters	Source of Capital	Frequency of Processing			Number of packs/bottles per schedule
		Once a month	Twice a month	Others	
Sugpon Food Processors Association					
1.Ube wine (750 ml/bot.)	LGU and members capital build-up		√		50-100 bottles
2. Ginger tea (125g/jar)		√			100-200 jars
3. Turmeric tea (125g/jar)		√			100-200 jars
Green Thumb 4-H Club					
1. Potato chips (50g/pck.)	LGU and members capital build up			by order	50-150 packs
Samantha's Livelihood					
1. Potato chips (50g/pck.)	DOST	√			50-200 packs
Taynan Family Livelihood					
1. Potato chips (50g/pck.)	Members capital build-up	√	√		100-150 packs

the potato chips produced by Taynan's Family Livelihood, Samantha's Livelihood and Green Thumb Livelihood, the computed ROCE ranged from 24.76%–25.94%. This is comparable with the NPRCRTC experience where their ROCE is 25.02% (NPRCRTC, 2011).

The reason for varied income is due to the varied price of raw material like the potato for example, with price ranging from Php20.00 to Php30.00 per kilo; packaging costs Php0.75 to 5.00 per piece depending on the quality; and the wage ranging from Php150.00 to 200.00 per day/person. The price of raw materials affects the production cost and the wholesale price of processed products. Lower price places the product within the budgetary limitations of a greater number of buyers, thus increasing the market potential (Johnson, 2015).

Problems Encountered by the Adopters/ Associations

The identified adopters have encountered different challenges during the operation of their business. The biggest challenge is the high and unstable price of raw materials followed by unpaid credits by the middleman, which causes loss of their capital, and family problems like misunderstanding between the processor and relatives. These problems affect the eagerness of the processor and their decision to continue or not to continue what they started. The limited market outlets or lack of market promotion is another main problem of the associations in their livelihood operations (Table 7) which affects the continuous supply of their processed products.

Table 6

Production Cost and Estimated Income of Technology Adoptors

Products of Adopters	Production per month	Production Cost (Php per bot./ jar/pck.)	Wholesale Price (Php)	Mark-up (Php)	ROCE (%)
Sugpon Food Processors Association (5 Members) 2016					
Ube wine (750 ml/bot.)	50 bot.	65.30	90.11	24.81	37.82%
Ginger tea (125g/jar)	198 jars	45.51	61.01	15.50	34.06%
Turmeric tea (125g/jar)	185 jars	40.60	52.00	11.4	28.08%
Green Thumb 4-H Club					
Potato chips (50g)	150 pcks.	17.50	21.90	4.40	25.71%
Samantha's Livelihood					
Potato chips (50g)	200 pcks.	23.82	29.77	5.95	25.94%
Taynan's Family Livelihood (2 members) 2017					
Potato chips (50g)	150 pcks.	26.45	33.06	6.61	24.76%

Table 7

Problems Encountered by the Associations/Processors in their Business Operation

Name of Association	Problems Encountered in Production
1. Sugpon Food Processors Association	• Unstable price of raw materials • Lack of market promotions/limited market outlets • Price of potatoes for the past few years were high
2. Green Thumb 4-H Club	• Products are unpaid (credit)
3. Samantha's Livelihood	• Unstable price of potatoes • Family problem
4. Taynan's Family Livelihood	• Lack of raw materials, unstable price

Conclusions

Processing technologies for rootcrop and fruit commodities like potato, sweetpotato, yam, gabi, cassava, ginger, and banana were disseminated/ promoted to 487 individuals through 14 beneficiary-initiated trainings during the period 2010 to 2014. Of the 487 total trainees, 33 participants who adopted selected processing technologies were interviewed.

Preliminary results of the intervention assessment showed that out of the 39 recipes disseminated, the respondents adopted 16 processing technologies. Twelve recipes, namely: ube, sweetpotato, and potato halaya, sweetpotato juice, puto, camarind and maja, cassava flour, starch, 'pitchi-pitchi', 'kutchinta', and 'bibingka', were adopted by 20 individual participants for home consumption. The products ube wine, ginger tea, turmeric tea, and potato chips were adopted as a source of livelihood by the associations with a total of 13 members. One association modified a part of the process in potato chip production, which increased their production efficiency.

For the products adopted as livelihood or supplementary source of income, the computed ROCE ranges from 24.76% to 37.82%. Ube wine gave the highest computed ROCE at 37.82%, followed by instant turmeric and ginger tea with 28.08% and 34.08%. Taynan's, Green Thumb 4-H Club and Samantha's potato chips gave the lowest with 24.76%, 25.71%, and 25.94% respectively.

In their small-scale business operation, problems mentioned include high and unstable price of the raw materials, unpaid credits, and family problems. The lack of market promotion and limited market outlets are major problems encountered by the associations/livelihood groups, which affects the continuous production of their processed products.

Recommendations

Out of the 487 training participants, only 33 (6.44%) respondents were interviewed due to limited budget. Further monitoring of the participants of the rootcrop-based processing technologies is recommended to involve more respondents for broader representation of results. Monitoring the modifications done by adopters may contribute to the enhancement of existing technologies.

For the profitability analysis, it is recommended to use the Return of Investment (ROI) as basis for computing to really see if the small scale business is really gaining, because depreciation cost and others are considered compared to ROCE analysis where only the ingredients, packaging materials, fuel, labor and other paid-up expenses are considered in product costing.

The trained participants can seek the assistance of other government agencies like the Department of Trade and Industry, LGUs, and others to link them to the market by inviting them to attend trade fairs and others. In addition, it will be useful to include module on simple marketing management strategies in future BSU-NPRCRTIC training packages for rootcrops and fruits-based processing technologies.

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