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Cassava and Sweet Potato in Western Seram, Maluku Province: Diversity, Cultivation and Utilization

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Abstract

Small islands in Maluku have a high diversity of root crops, with cassava and sweet potato being among the most common. The objectives of this research were to study the diversity of cassava and sweet potato in Western Seram, their cultivation systems, their role as staple food crops and to collect the accessions *ex situ*. This study used a survey method in 15 sample villages/*negri* scattered throughout Western Seram. Morphological characterizations used cassava and sweet potato descriptors (adapted from HUAMÁN [1991] and Fukuda *et al*. [2010]). Information on the local varieties, their cultivation and utilization was obtained by Focus Group Discussion (FGD) plus interviews with farmer respondents from the sample village/*negri*. Secondary data were gathered from a desk study. From the surveys, 105 cassava accessions and 71 sweet potato accessions were found and collected. They were grown under mixed culture/agroforestry system called *kabong* or *dusun*, consisting of forestry plants, spices, perennial and annual crops. Inamosol Subdistrict which is in an inland (non-coastal) region has the greatest diversities of both crops. Both crops were found to be among the most important staple food sources, in addition to sago and cereals. Their ease of cultivation and adaptation to a wide range of geographic conditions made them have an important role as security food crops in Western Seram.
Keywords: agroforestry, food security, genetic diversity, germplasm, staple food

Introduction

Cassava (*Manihot esculenta* Crantz, Euphorbiaceae) and sweet potato (*Ipomoea batatas* (L.) Lam., Convolvulaceae) are annual root crops which are classified as *palawija* (non-rice annual food crops) in Indonesian agriculture. They are important food crops in eastern Indonesia. In the archipelagic Maluku Province (the southern half of the Moluccas), cultivation of these crops is spread widely in medium and small islands, primarily as subsistence crops and food reserves. Thus, these root crops also have an important role in food security and resilience. Both of these root crops are grown in most of the islands of Maluku as a component of plant cultivation systems of *kabong* or *dusun* (polyculture,

agroforestry), and especially has a role as a source of staple food for the families. They are an important source of carbohydrate, besides rice and sago. Rice has increasingly displaced the position of sago and root/tuber crops as the major staple food sources. However, there is a determination of the local government and the community recently to revive the role of root crops and sago, which will strengthen food security in the region.

Traditional farmers in Maluku who grow cassava and sweet potato usually use several cultivars or landraces on their lands. Tens or even hundreds of landraces can be found in a region. For example, studies conducted previously showed that in one village in Maluku more than 10 different sweet potato accessions were found (HUKUNALA 2010, MAITIMU 2008). Studies in the field have also shown that the same is true of cassava.

Scientific studies which include germplasm characterization, genetic and agronomic evaluation and estimation of crop potentials of both root crops have been conducted in Western Seram District in order to strengthen its role in supporting food security and enhance their economic value. So far the two root crops still have limited roles as subsistence crops. Currently there is 13,000 ha of potential land for food crops in Western Seram District, which can be planted with cassava and sweet potato. Thus, space for development of both crops is still wide open toward their utilization for home industries and for supply of raw materials for the food and beverage industry, animal feed, chemical and pharmaceutical industries in the future.

As subsistence crops, cassava and sweet potato are considered to have low economic and social values. Their roots are generally consumed immediately after being boiled or fried. Processed products from these crops are still very limited in Maluku, for example in the form of *enbal* dry bread (in Southeast Maluku), *suami* and *keripik* cracker from cassava, whereas sweet potato is only prepared by boiling/steaming and frying. Thus, possibility for their processing development is still very widely open, to improve the roles of both crops in addition to that of subsistence one.

To strengthen the role of cassava and sweet potato, both as a subsistence or food security and as cash crops in Western Seram District, various information need to be collected about the genetic resource potentials of both crops in Western Seram, cultivation land sizes at the farmer level, farming technology level applied by farmers and utilization of the crops.

Objectives

The objectives of the research described in this paper are to: 1) explore, collect and describe the genetic diversity of cassava and sweet potato in Western Seram, 2) study cultivation and utilization of cassava and sweet potato by farmers in Western Seram and 3) study the role of both crops in the supply and diversification of staple food.

Methodology

This research was conducted with an exploratory survey, involving exploration, morphological characterization of cassava and sweet potato germplasms, as well as collection of data about their cultivation and utilization at farmers' level. In this research, a desk study was also undertaken, which began with collection of secondary data and literatures relevant to the achievement of the research objectives, information about geographical conditions of the fields.

The location of the exploratory survey that was conducted from July to October 2012 was Western Seram District, with 15 village samples within 8 subdistricts that were geographically spread throughout the district, on north, west and south coastal areas and inland areas. It covered the subdistricts: Inamosol, Kairatu, Kairatu Barat, Seram Barat, Hunamual Muka, Waesala, Taniwel and Taniwel Timur.

Assignment of the sample villages and farmers were conducted with purposive sampling. One to two sample villages were taken from each of the 8 subdistricts. The number of respondent farmers was 4–8 per village. Information from the farmers was gathered through guided interviews and Focus Group Discussion (FGD), which were guided by questionnaires. Heads of villages (*raja*) and Agricultural Extension Workers (*Petugas Pertanian Lapangan*, *PPL*) were also included as key informants in separate interviews. Observations of crops were conducted directly in the sample farmers' fields, to collect data on the cultivars/landraces of cassava and sweet potato that were grown and their cultivation techniques. Observations to obtain description and characterization data were performed with morphological description forms which were previously prepared based on descriptors of cassava and sweet potato (FUKUDA *et al*. 2010, HUAMÁN 1991).

Results and Discussion

Cultivation of cassava and sweet potatoes in Western Seram

The climate in Western Seram District belongs to a tropical marine climate. It is strongly influenced by the surrounding wide seas and by the monsoon climate, i.e., the North West or East or Southeast seasons. A change of seasons is always punctuated by a transitional season (*pancaroba*). Based on the records of rainfall and number of rainy days for the 2011 (Kairatu Climatology Station), the peak of rainy season occurs between June and August.

Cropping patterns of cassava and sweet potato by farmers are based less on consideration of season. They are based more on the habits of the local farmers. After land clearing or previous harvest they immediately plant the crops. Replanting was done immediately after harvesting previous crops with no or minimal land preparation. Cassava with different harvesting ages is harvested as needed for daily family consumption. Sweet potato is usually planted at the end of the rainy season, and its harvest time is more based on the harvest ages.

Western Seram District is a second-largest cassava producer district in Maluku after Central Maluku District. Harvested areas of cassava and sweet potato in Western Seram in 2013 were 9,810,000 ha and 458 ha, with a production of 176,900,000 t and 5,137 t fresh roots, respectively. This means that the productivity of both commodities was relatively low, amounting to about 18.0 t/ha for cassava and 11.2 t/ha for sweet potato (BPS 2014).

To support the economy and food security of Western Seram District, the expansion of planting area of cassava and sweet potato are still very possible, considering the district still has a large enough suitable potential land for food crops, amounting to 13,000 ha (BPS 2012). For Maluku Province, development of the root crop cultivation can be directed to dry land suitable for food crops, namely IV and IV ay ax zones, amounting to 718,000 ha in Maluku (SUSANTO and BUSTAMAN 2006).

In Western Seram, cassava and sweet potato are generally grown in mixed cultivation systems called *kabong* or *dusun*. These systems are practised by indigenous inhabitants of Western Seram, i.e., the Alune and Wemale ethnics, from the coast up to the upland. In such a cultivation system, both crops have an important role as a source of subsistent staple food which also means to contribute to food security of the people. Therefore, efforts to increase their production will strengthen their food security.

Although in the urban areas the position of root crops has been increasingly displaced by rice, in the rural areas traditional communities still maintain a diet with mixed staple food sources, consisting of tubers (especially cassava, sweet potato, yams/*Dioscorea* spp., taro and cocoyam), sago, plantain, corn and some legumes. Cassava and sweet potato are the staple food sources that are very important for and generally prefered by Western Seram people. They also 'must be present' in the foods provided in traditional events.

Many subsistent, traditional and relatively underdeveloped farmers can still be found in Western Seram District, whereas more advanced farmers are concentrated in transmigration areas, such as in Kairatu and Kairatu Barat, which were not included as sample areas. In general, ownership of cultivated lands ranged between 0.25 and 2 ha per farmer family. The practised agriculture systems are mixture of annual crops (maize, beans, root crops and vegetables) and the more dominant perennial plants (bananas, clove, nutmeg, coconut, cacao and others).

Cassava and sweet potato are grown as subsistence crops and as sources of carbohydrates, generally with small acreages ranging from 100 m^2 to 0.5 ha of the total farmers' cultivated lands (0.25 to 2 ha). They are among the dominant food crops; nevertheless, their cultivation areas are small. Most of the farmers' lands are planted with perennial crops cash crops. This pattern of cultivation is actually the result of cultivation system that is directed towards the establishing perennial crop plantation, which is practiced by most farmers in Western Seram. The system starts from forest clearance by slashing (*pameri*) and burning (*pembakaran*), minimal land preparation/tilage and planting of initial annual crops. In the first year, the land was planted with cereals, legumes and vegetables, which will gradually be shifted to root crops, including cassava and sweet potato, as well as

bananas. At the same time in the early years of the land opening, the newly cleared land is planted with seedlings of or young perennial crops. Establishing a perennial cash crop plantation generally becomes the main long-term goals. The main perennial crops include coconut, cloves, cacao, nutmeg, varieties of fruit, multipurpose and timber trees. Sago trees are rarely planted intentionally. During the time that the perennial plants is growing into production ages, subsistence food crops are grown in the spaces between the growing perennials. In such a system, cassava, sweet potato and other root crops are the dominant crops grown, when the soil fertility has begun to decline and less suitable for cerreals, legumes and vegetables, and when the annual cash crops are growing into production ages.

All respondent farmers grew cassava and sweet potato among various crops and plants in a mixed cropping system, either with or without regular arrangements. In Seram, this type of mixed cropping system is called *kabong*. Other root crops that are grown in the such a land include cocoyam (*Xanthosoma sagittifolium*), yam (*Dioscorea alata*) and *gembili* (*D. esculenta*), in addition to other important sources of carbohydrates, namely banana, sago, upland rice and corn. In agriculture system adopted by farmers in Western Seram, land preparation techniques is done by slashing bushes and felling some trees (*pameri*), followed by burning them when dry. For cultivation of food crops, including cassava and sweet potato, most farmers apply no- or minimal tillage. A simple soil preparation is done to form *kuming* (mounds to plant cassava or sweet potato cuttings) using tools that include hoes, wooden drills and other tools with a low efficiency. The cost for production facilities is usually low because it is only needed to buy hoes, machete or other simple tools that can be used for many years. Sometime manure is used, but synthetic fertilizers and pesticides are rary applied. Intensive crop maintenance are rarely practiced. Family labor is usually not considered as a component of cost. Thus, in the *kabong* cropping system, input cost for the root crop production is low. This farming system is basically a traditional agricultural system that has been employed for generation by the various communities living in the villages and near the forests. The low input system is initially applied in cassava and sweet potato cultivation because of a lack of capital other than the land, as well as a lack of education and training on agriculture technology.

The respondent farmers rarely grew cassava and sweet potato with orderly plant spacing. During field observations, irregular plant spacing ranging from 0.6 m x 0.6 m to 1 m x 1 m for cassava and 0.25 m x 0.5 m to 0.5 m x 0.5 m with 1–3 cuttings per mound for sweet potato were found. Some farmers take into account planting season for cassava and sweet potato, i.e., the end or after the rainy season (August to December). Nevertheless, most farmers do not take into account certain months as cassava planting season. Cassava are planted throughout the year, that is right after harvesting the previous crop. On the other hand, farmers tend to plant sweet potato at the end of the rainy season.

Because cassava is generally harvested in accordance to the need for family consumption, there is practically no harvest season for cassava. Either cassava or sweet potato is not harvested at once, but as needed for family consumption or for sale at a small scale. Root

sales are usually done locally and in a small scale (Fig. 1). Transporting further to other regions is rare. This is related to the fact that farmers in Western Seram seldom store cassava and sweet potato storage roots for more than several days, except "storing" with the plants alive or by delaying harvesting. Live storing is seldom practised for sweet potato roots, because farmers know if they are harvested late (after the harvesting age) then a high percentage of the storage roots will get damaged. Farmers generally do not dry the roots, make *gaplek* or cassava flour, as practiced in Java. They harvest the roots as needed, so that excess of production is not common. Sweet potato roots are also utilized only in fresh condition. According to the farmers, harvesting age for cassava ranges from 3 to 12 months (mostly harvested at 6 months of age), and for sweet potato 3 to 4 months.

As a result that the farmers do not harvest cassava and sweet potato simultaneously in one cropping season, it is difficult to predict their yields per unit area. It is also complicated by the fact that farmers do not weigh the harvested storage roots. However, a raw estimate of yield for cassava is between 2–5 kg per plant (≈20–50 t/ha). This is higher than that stated by ALFONS and WAMAER (2015) on the estimated productivity of cassava in Maluku of 12 t/ha or the Maluku statistical data (BPS 2012) of 17.87 t/ha. Estimated productivity of sweet potato is 1–1.5 kg per plant, or approximately 20–30 t/ha.

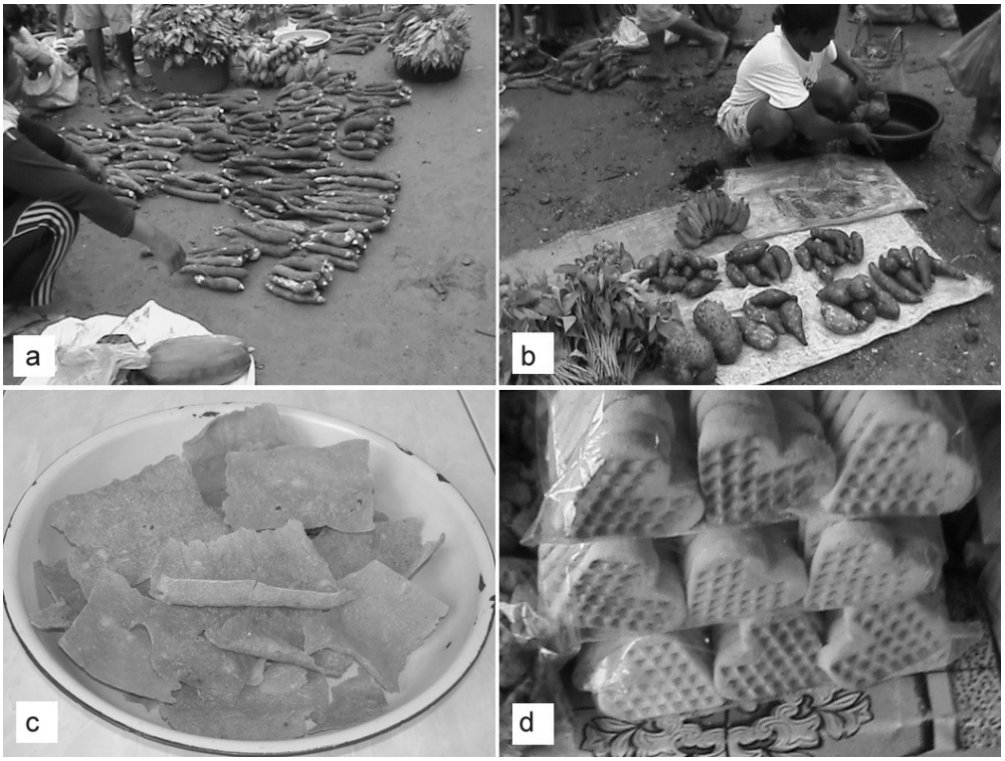

Fig. 1. Marketing and processing of cassava and sweet potato in Western Seram; (a) and (b) small-scale sale of fresh roots in a local market in Piru, (c) and (d) processed cassava in the forms of dry products, such as crackers and *embal* (a dry poisonous cassava bread).

Cuttings as planting materials used by farmers are generally obtained from the plants grown previously and only rarely do farmers obtain them from other farmers or from neighboring villages. From the observations in the respondent farmers' fields it was found that the farmers grew in average one to three varieties of cassava or sweet potato on their field. However, it was also found that some farmers grew more than five varieties of cassava on their field, such as those found in Morekao (West Seram Subdistrict), Seaputih (Hunamual Muka Subdistrict) and Musihuwey (Taniwel Timur Subdistrict). In Ursana (Inamosol Subdistrict), in a field of a farmer group 6 sweet potato varieties were found. Such farmers can be seen to become "collectors" of local varieties (landraces) and may play a role in the *in situ* conservation of the genetic diversity of cassava and sweet potato.

The main reasons that respondent farmers grew a particular variety of cassava or sweet potato were the good taste (taste preference) and the earliness of harvesting age. But there were also an indication that farmers grew a particular variety because it was common (known for generations), the planting materials were available or because the farmers did not see other options. This was supported by the fact that the farmers did not grow new high yielding varieties because they were never available or accessible. Thus, the establishment of planting material supply system for cassava and sweet potato, which are reproduced vegetatively, is needed in Western Seram District. The farmers need to be assisted to grow cassava and sweet potato varietes that are productive and with clear identities, in order to guarantee a high productivity and in turn a better income.

Most farmers grew cassava and sweet potato just for their own consumption and only a small portion was for sale. In spite of such farming conditions, according PESIRERON *et al*. (2011) the average food crops in the Western Seram District were economically feasible because they had Revenue/Cost (R/C) values > 1. Based on the results of the financial analyses of R/C for cassava and sweet potato farming in the Western Seram District, the values of 1.93 and 1.30, were obtained respectively, which means they were feasible to be cultivated by farmers in the region (PESIRERON *et al*. 2011).

Results of interviews with the farmers indicated that there were still many obstacles in the cultivation of cassava and sweet potato, including the climatic factors, pests, especially wild pigs (*Sus scrofa*), labor and marketing. The application of technological innovation on the traditional farmers has been generally hindered by biophysical, sociological, technological and economic factors. The application of technology for cassava and sweet potato production was still very limited in the study area. Therefore, it is very possible that increased productivity can still be achieved through an effort of providing planting materials of superior varieties and various other agricultural inputs.

Diversity of cassava and sweet potato in the Western Seram

In situ characterization of cassava and sweet potato accessions in the farmers' fields have been conducted using descriptors adapted from those of HUAMÁN (1991) and FUKUDA *et al*. (2010). In this research, 105 accessions of cassava were obtained and collected from 8

subdistricts, namely Inamosol, Kairatu, Kairatu Barat, West Seram, Hunamual Muka, Taniwel, Taniwel Timur and Waesala. The highest cassava diversity in Western Seram District (in hilly inland region) was found Inamosol subdistrict with 17 cassava accessions, followed by Taniwel Timur Subdistrict with 15 accessions. The number of accessions found per sample varied from 2 accessions (Kamarian and Kamal) to 12 accessions (Morekao).

Most of cassava accessions obtained (98 accessions or 93%) belong to the type that can be consumed directly (sweet cassava, with low hydrogen cyanide [HCN] content). Only seven accessions belong to the bitter type (with high HCN content) which can not be consumed directly without special processing, and one of them is considered to be very toxic cassava (Kasbi Galela). Based on the HCN content, cassava is classified into either sweet cassava, with a HCN content < 40 mg/kg of fresh roots, or bitter cassava with a HCN content ≥ 50 mg/kg of fresh roots. High HCN content can cause poisoning to human and animals, so cassava with a high HCN content is not recommended for fresh consumption (SUNDARI 2010). Most of the accessions obtained have white root flesh. Seventeen accessions (16.2%) have yellow root flesh and 3 accessions (2.85%) have cream root flesh.

From the exploratory survei, 71 sweet potato accessions have been obtained and collected from the 8 subdistricts. The highest sweet potato diversity was found also in Inamosol Subdistrict with 18 accessions, followed by West Seram and Taniwel subdistricts with 9 and 7 accessions, respectively.

The data described previously indicate that Western Seram District has high genetic diversities of cassava and sweet potato, which also means that the region is rich of genetic resources of both crops. The root crops have long been spread in the region, so that in the long term this has enabled formation of many new genotypes probable through natural cross breeding. The habits of farmers that do not use new superior varieties but rather use several local varieties (landraces) simultaneously has allowed the *in situ* conservation of the diversity of these two crops. The genetic diversity is a very valuable source of genes that are important for breeding programs of the crops in the future.

Processing, utilization and home industry of cassava and sweet potato in Western Seram

Each family of the respondent farmers had an area of land for subsistence annual crops and perennial trees that ranges from 0.25 to 2 ha. Cassava and sweet potato fresh products were generally consumed by the farmers' family or sold in a small scale. However, their processed products were found to be limited. Communities in the study area, especially those who have the main livelihood as farmers, consume cassava and sweet potato that have been grown by themselves as staple food sources. They do not buy them in the market. In addition to cassava and sweet potato, people also consume rice as a staple food eventhough they do not grow rice. They buy rice with the money they obtain from sales of other agricultural products or from other revenue.

Cassava and sweet potato can be consumed as a staple food because their storage roots contain a high carbohydrate, which is 34.7 and 25.6 g/100 g of material, respectively. Cooked

roots of cassava and sweet potato are eaten with side dishes such as fish, meat and vegetables, to improve nutritional values. In addition to the carbohydrate content, the storage roots also contain protein, but not as much as rice. Their fat, vitamin A and vitamin C contents, however, are higher than those of rice. The calcium contents in cassava and sweet potato are even higher than rice, i.e., 33 and 27.7 mg/100 g, respectively, compared to 6 mg/100 g in rice.

The common daily meal composition of the community in Western Seram is roots/tubers/sago/rice-vegetables-fish/meats. The food composition consists of carbohydrates as an energy source, proteins and fats from the fish/meats as well as vitamins and minerals from the vegetables. In general, cassava and sweet potato, as well as vegetables, are obtained from the farmers' own gardens. Whereas fish or meat as a protein source are purchased or are obtained from the sea or the forest. Cassava and sweet potato plays an important role as staple food sources, especially in rural farming communities. In many other regions, cassava is an important food for the farmers only in certain seasons when other foods are less available or more expensive (FALCON *et al*. 1986). However, in most of Western Seram cassava along with the other root and tuber crops are still the major and daily staple food sources, comparable to sago; and in some communities they are consumed greater and more often than rice. This suggests that in Western Seram, the community, especially the farmers, still maintain diverse staple food sources other than rice. The consumption patterns in the study area thus provide a significant contribution to better security of staple food supply and provision of balanced nutrition for the community.

In addition to being consumed as a staple food, cassava and sweet potato are also cooked into snack foods. A limited quantity of cassava is processed into processed products. Cassava leaves are cooked as a vegetable. In all the study villages, the only common daily cooking method of cassava and sweet potato for staple food is by boiling or steaming the fresh storage roots. For production of snacks, cassava roots may be processed into fried snack, *onde-onde* and *lemet*; whereas sweet potato roots are commonly prerpared by frying. Both may be cooked into *kolak*, a sweet soup made from a mixture of tuber and plantain cubes with brown sugar and coconut milk.

In the food consumption system, diversification is an important aspect. The diversification of processed cassava and sweet potato is one of the alternatives to support of the food diversification program promoted by the government. Food diversification is intended to gain nutrient diversity as well as to free the community from dependency on one particular type of staple food source, particularly rice. High dependency on a particular type of food sources, such as rice, can lead to instability if the supply is interrupted. Based on the findings, it can be stated that cassava and sweet potato play an important role for food security in Western Seram.

In Western Seram, cassava and sweet potato storage roots are generally consumed by the people as a staple food and only a small portion of them is processed into a variety of traditionally processed products, either to meet their own need and for sale. Therefore, the utilization of cassava and sweet potato should be encouraged and developed further by

developing new and more modern products with a better nutritional value and with an application of food technology. Given the fact that cassava and sweet potato fresh storage roots are perishable and their fresh conditions last only several days after harvesting, proper handling and processing techniques should be applied to extend their shelf life. Cassava and sweet potato can also be upgraded into higher value food products. However, this study found that product processing of both comodities is rarely performed by Western Seram farmers, because they lack capabiliy of agriculture product processing technology.

In the rural area, cassava and sweet potato can be processed directly into a variety of wet and dry foods, and the resulting products can have a variety of flavors. One attempt to preserve the two commodities can be achieved by processing them into flour and the flour can be processed further into a variety of interesting food products. Flour-making technology can become a choice to be recommended to the farmers to produce a semi-finished product. The flour is durable to store, easily blended, can be fortified, and can be cooked faster into various foods, which is more suitable to the practical modern life (e.g., ANTARLINA 1998, ONYENWOKE and SIMONYAN 2014).

Small business development goals in rural areas, among others, should be directed to increase employment opportunities, especially to absorb labor in the agricultural sector, to increase added values of agricultural products, and to increase incomes of the rural community. Therefore, agribusiness development program of production and utilization of local crop resources, such as cassava and sweet potato, by developing food home industry needs to be initiated by the government of Western Seram District.

Because cassava and sweet potato cultivation in Western Seram is generally a small-scale activity, its upstream and downstream development efforts should be devoted to developing small agribusinesses that is efficient and involves farmers' family labors. To lift the economic value of cassava and sweet potato, processing technology development as well as a good marketing strategy are needed, which in turn can improve the image of the root crops as inferior food into widely accepted one. This will expectedly increase consumers' acceptance of cassava and sweet potato products. Efforts to increase the added value of cassava and sweet potato through agro-industry can also play a role in supplying staple foods that are more diverse and with better qualities. Through the development of rural home agro-industry, the quantity of staple foods can be increased and the types of their products available in the market will be more diverse.

Constrains faced by the farmers to develop downstream agribusiness include lack of skills and mastery of post-harvest handling and product processing technology. Such constrains affect farmers' income which tends to be low. Another alternative to improve the income of farmers is by developing product diversification. The cassava and sweet potato fresh storage roots may be processed into refined products that can be stored longer, among other into flour, starch, dried roots, chips and pellets. By this, the market of the commodities is expected to be better guaranteed, their added values increased, and in turn well-being of the farmers improved.

Conclusion

Conclusions from this research are as follows: 1) cassava and sweet potato are rarely grown in a monoculture system in Western Seram, however, they are important crops in a mixed farming system called *kabong* and *dusun*, 2) both play an important role as subsistence crops and major sources of staple food, 3) farmers' planting areas of cassava and sweet potato are generally small (patches less than 0.25 ha) and only small portions of the whole lands owned by the farmers, 4) their cultivations are traditional, low-input and low-technology ones and long fallow cultivation is commonly practiced by the farmers to recover soil fertility, 5) the genetic diversity of cassava and sweet potato in Western Seram is large, however, conservation, assessment and utilization of their germplasms are still very limited and 6) only limited post-harvest processing of cassava and sweet potato products are applied.

Therefore, possibilities are still open: 1) to increase production in order to strengthen their position as staple and security food sources, 2) to diversify their intermediate processed products, such as dried cassava, chips, pellets and flour, to ease storing, transporting and marketing and 3) to diversify and improve quality of foods based on both crops.

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