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Development of pig farming based on Sili systems as a prototype of integrated agriculture farming system on highland West New Guinea, Indonesia

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Abstract. The Sili as local wisdom of integrated farming systems can sustain livelihood of households. The objective of study was to perform the roles of such local wisdom of the Sili into pig farming systems. Study was done in highland of Jayawijaya, Papua. The 40 silyls were observed and 109 farmers were interviewed. Data gathered and stored into Excel Ms and descriptively analyzed. The finding of this research was household/Sili was 2-3 family, ages 46-55 years, sili size was 11-16 (35%), monthly income 1-3 millions/hh, source of income derived from integrated farming systems, crop grown 7-9, bedding was old and new shapes, livestock reared dominated by poultry, native pigs 90%, experience in raising pigs 1-20 years, and piglets production was 346 heads. Pig farming practice dominated by free range and confinement. The feed offered twice/day using sweet potatoes root and vines. Breed sourced from market, relative and previous stocks was selected using indicator of fast growth and healthy.

1. Introduction

Since the beginning of their cultivation history, a pure organic farming system [1–5] has been practiced so that soil fertility depends on pig waste and the nutrient which is inside the trenches made up for surrounding the crop bedding. A major constraint to crop production in the region is that the land used for planting sweet potato is the land that had been used for 5-6 harvesting seasons then rested for between 2 to 6 years as fallow land [6–9]. This often results to the long distance the farmers have to walk to get to the new plot for planting. The area could be reached in about 2 – 3 hours by foot. The land ownership being practiced is clan system. Lately, farmers practice mixed crop – pig farming system with sweet potato (*Ipomoea batatas* L.) as the dominant crop [3,6,10–14]. Other common crops include cabbage,



carrot, green beans, potato, tomato and assorted vegetables. Native pigs are the main livestock and most of the farmers feed their pigs once a day which is early in the morning before the farmer goes to the farm [15–19]. The pigs roam around for the whole day in communal rangeland and return back to the pen near the homesteads at night. The main feed for the pigs are sweet potato roots and vines that are either cooked and/or uncooked. Close interaction between crops and livestock occurs through the use of crop residues as fodder for the pigs and the reciprocal use of pigs manure to fertilize the crops .

Sili is an important part of the Dani traditional “household” systems . A *sili* consists of several Dani households who live together and follow an ethic of *sabokhagon* which means “one for all and all for one”, living and working together as a *sili* unit where there is no separate ownership. Farm infrastructure, gardens, sweet potatoes and pigs are owned and shared collectively under the management of a chief who controls access and rights for the benefit of all *sili* members. A *Sili* is a living compound surrounded by wooden fencing and is composed of one or more family/(ies) and each family is headed by a male with one or more wives . Because it is composed of more than one household, *Sili* is considered a small community in a village. *Sili* is also considered as a single unit of production and consumption and is assumed that consensus among *Sili* members existed on the allocation of resources and benefits and that *Sili* members’ interests

2. Materials and Methods

2.1. The research site and farm

The research was carried out from April to August at pre-selected villages and respondents in the Baliem Valley, Jayawijaya Regency, Papua Province, Indonesia. Baliem Valley is a landlocked area and is composed of 11 districts. The farmers are mainly engaged in organic sweet potato – native pig production apart from forest product gathering. The area has a high potential for crop production, with an annual rainfall of 750–1000 mm. A survey was done to assess and characterize the native pig raisers and their major production system practices in an integrated organic sweet potato – pig production system. Since the physical, biological, socio-cultural, economic, and farming systems characteristics of the study area are similar, the secondary data provided by Bureau of Statistic and Bureau of Animal Husbandry were used as basis in selecting research sites. Four districts with the highest pig population were selected using Judgmental Sampling. Selection of a village as research site was done by the leaders of the districts. Ten (10) *Sili* (where the pig raisers and the family members live) per village were randomly selected based on their willingness to be interviewed (Table 1). Ten randomly selected *Sili* in each of the four (4) top swine producing districts were interviewed. All selected districts and villages are inhabited by the Dani Tribe. The *Sili* is the central decision-making unit of the farming system in this research site. Problems are identical. *Sili*, therefore, is the unit of analysis in this research.

Table 1. Distribution of *Sili* in selected villages and household interviewed.

Villages	No. of selected <i>Sili</i> per village	No. of household per selected <i>sili</i>	No. of respondent per selected <i>sili</i>
Kama	10	39	28
Jiwika	10	40	25
Laytopo	10	37	29
Hubikosi	10	38	27
Total	40	154	109

In this study, primary data were collected from the respondents in every *Sili* in two phases. Phase 1 involved Participatory Rural Appraisal (PRA) approach in which 15 people of different groups and gender per village participated in the meeting held in each village office. The PRA [20–24] served the purpose of opening up discussions with villagers on a particular topic of interest. This, being participatory in nature allowed the local people to share their knowledge, experiences information to

everyone. PRA techniques were explained by using mapping, group discussion, triangulation or cross-checking, direct observation and/or participant observation. Phase 2 involved the use of structured and semi-structured questionnaires and semi-structured interviews for household and key informants, respectively. The key informants who were interviewed included district chairperson, village chairperson, village elders, church leaders in the village, village traditional leader, and former farmer organization leader. Before embarking on the field work proper the questionnaires were pre-tested in the selected villages. Secondary data from existing literature was also collected i.e. from ACIAR Phase I Project Report. There were 109 households from 40 *Sili* of the four villages interviewed. Households interviewed were selected randomly so as to avoid bias and based on their willingness to be interviewed. Four farmer focus group discussions were held in four villages of Jiwika, Laytopo, Kama and Hubikosi. The chair and the secretary of each village assisted in recruiting the participants for the meetings. A total of 8 to 12 pig farmers, men and women, per village, were invited for the focus group discussions. Discussions were held in the village office and were conducted in the early hours of the afternoon. Intensive discussions were also conducted for every local extension worker and two local institution leaders (head of the district) per village based on their time and place. Direct dialogues were also done with local agricultural and livestock officers as well as with an international NGO, i.e. ACIAR. Quantitative data collected were the body weight of the pigs, nutrient content of forages and earthworm, and number of healthy and sick pigs sold out in the local market as well as their prices. The different range areas in Jiwika Village, Kurulu District were explored at different times from as early as 8 am to 6 pm. Two sows, with 8 and 11 piglets each and one gilt with a boar were observed and tracked down during their range of periods. The researcher followed the animals wherever and whenever they went. Locations of the pigs at different periods were pinpointed using Global Positioning System Garmin 76 CSX. Data were retrieved and transferred to computer. Samples of forages, grasses, and earthworms eaten by the pigs were taken to the Biodiversity Research Centre of the State University of Papua and University of Gadjah Mada for proper identification and nutrient analysis, respectively.

All data gathered were tabulated and analyzed using simple statistical tools such as summation, average, percentage, and frequencies.

3. Results

3.1. Households' characteristics

The combined socio-demographic profile from the 40 *Sili* described in terms of age, sex, civil status, educational attainment, *Sili* size, households per *Sili*, number of wives per household, income and source of income are shown in Table 2. The number of households per *Sili* ranged from 1 to 4 with an average of 3 households. *Sili* with 2 (35%) and 3 (42.50%) households predominate in this study. There were only 2 *Sili* which had 1 household while 7 *Sili* had 4 household. Every household head in this *Sili* would share their resources together.

The age of household heads ranged from 38 to 68 years old with a mean age of 48 years old. Majority of them (60.00 %) belonged to the middle age of 46 - 55 years old, 35% belonged to the younger age bracket of 35 - 45 years old and only 5% were more than 56 years old. This indicates that while the household heads were growing older, they were not being replaced or succeeded by the younger generation. It also suggests that young farmers are needed in order to maintain or increase their farm production.

Sili size is the actual number of members living within the *Sili* at the time of the study excluding those who are gainfully employed and no longer living with the family as they are due to have their own family. *Sili* size for each *Sili* ranged from 8 to 28 members with 17 members per *Sili* as the average. The highest was 14 (35%) *Sili* which had 11 - 16 family members and the lowest was 5 (12.50%) *Sili* composed of 5 - 10 family members.

Table 2. Households' characteristic of the 40 *Sili* in Baliem Valley.

Criteria	N	Proportion	Mean ± Sd	Min	Max
Number of Household per <i>Sili</i>					
1	2	5.00	2.725 ± 0.816	1	4
2	14	35.00			
3	17	42.50			
4	7	17.50			
Age of the Head of Household, years					
35 – 45	14	35.00	47.898 ± 6.054	38	68
46 – 55	24	60.00			
56 - 65	1	2.5			
66 - 68	1	2.5			
Sili size					
5 - 10	5	12.50	16.75 ± 5.042	8	28
11 - 16	14	35.00			
17 - 22	13	32.50			
23 - 28	8	20.00			
Monthly Income, Rupiah (Rp.) *)					
1,000,000 – 3,000,000	17	42.50	3,963,000	1,200,000	8,920,000
3,001,000 – 5,000,000	11	27.50	±		
5,001,000 – 7,000,000	9	22.50	1,875,217.87		
7,001,000 – 8,920,000	3	7.30			
Source of income					
Raising Animals and Planting Crops	24	60.00			
Raising Animals, Planting Crops and Employment	16	40.00			

*) 1 US \$ = IDR. 9,800

The monthly income in this study is the amount of money the farmer and his family in a *Sili* obtained every month from their on-farm and non-farm activities as the main source of income. The average monthly income of every *Sili* was IDR. 3,963,000 which ranged from IDR. 1,200,000 to IDR. 8,920,000. Majority (42.50%) of *Sili* had monthly incomes between IDR. 1,000,000 to IDR. 3,000,000, followed by 27.50% with income ranging from IDR. 3,001,000 to IDR. 5,000,000, then a few (22.50%) whose income ranged from IDR. 5,001,000 to IDR. 7,000,000 and only 7.50% had a monthly income more than or equal to IDR. 7,001,000. If this monthly income is converted to daily income, the average daily income of each *Sili* was IDR.132,100 equivalent to US \$ 14.68.

Most *Sili* (60%) depended only on planting crops as the main source of income, while 40% of *Sili* had non-farm income from employment in the village and the district level aside from farming. Results of this study showed that all non-farm income came from the men while all on-farm income came from the women.

3.2. Organic sweet potato - native pig farming system profile

People living in the Baliem Valley had been practicing organic sweet potato – native pig farming system for hundreds of years, where the sweet potato and native pigs are the main source of carbohydrate and protein for human. Sweet potato per se is the staple food of human as well as the main feed for native pig. Reports on Jayawijaya in Figures year 2010 have shown that sweet potato contributes 94.67% to food crop production and occupies 71.97% of land for cropping in this regency. Planting sweet potato

and raising native pigs are the major on-farm activities; however, farmers also plant some other crops and raise other animals in order to meet their daily needs as shown in Table 3.

Table 3. Crops and animals production profile per *Sili* in Baliem Valley.

Criteria	N	Proportion	Mean \pm Sd	Min	Max
Number of crops grown					
4-6	15	37.50	6.875 \pm 1.285	4	9
7-9	25	62.50			
Number of bedding for cropping					
Old Bedding	14	35.00	24.43 \pm 6.998	12	
10 - 20	16	40.00			
21 - 30	10	25.00			
31 - 38					
New Bedding	9	22.50	26.30 \pm 8.134	13	43
10 - 20	19	47.50			
21 - 30	12	30.00			
31 - 43					
Type of animal raised together with pig per <i>Sili</i> , heads					
Cattle	2	5	40.5 \pm 9.138	35	46
Native chicken	30	75	3.7 \pm 2.360	1	9
Rabbit	4	10	7.2 \pm 7.225	3	20
Only pig	4	10	27.48 \pm 9.25	10	52
Type of pig raised					
Native	36	90			
Native and cross bred	4	10			
Years in native pig raising					
9 - 14	5	12.50	22.81 \pm 7.482	9.5	40.5
15 - 20	12	30.00			
21 - 26	6	15.00			
27 - 32	7	15.50			
\geq 33	5	12.50			

Table 6 shows that every *Sili* planted at least 4 kinds of crops with 9 crops, including vegetables and fruits, as the highest number of crops grown. The main crops were sweet potato, corn, cassava, and yam. Most (62.50%) of the *Sili* grew 7 to 9 types of crops in the small planting area using multi-cropping system with sweet potato as the main crop while the other crops were planted between the mound and surrounding sweet potato plots at the same time.

Through the subsistence cultivation practices, every *Sili* could have more than 10 beddings per planting season since crops, especially sweet potato, are the main source of livelihood of the farmers in Baliem Valley. In this area the farmers divided their garden into 2 based on their planting season called old garden (*kebun lama*) and new garden (*kebun baru*) with different sizes. The number of beddings per planting season per *Sili* will mainly depend on the *Sili* size, especially on the number of wives, and the number of pigs. In the old garden owned by every *Sili* the number of beddings varied from 12 to 38 beddings with 24 as the average. In the new garden, on the other hand, the farmers could have 13 up to 43 with 26 beddings as the average. Majority of *Sili* either in old garden (40.00%) or in the new one (47.50%) owned beddings ranging from 21 to 30. Some (35% and 22.50%) had 10 to 20 and some (25% and 30%) had more than or equal to 31 beddings in the old and new gardens, respectively.

Some farmers tried to search for another possible source of income from raising other animals aside from pigs. Native chicken, cattle and rabbit were the 3 species of livestock raised by the farmers to meet

their family needs. Native chicken was the most popular livestock (30%) raised by the farmers together with pigs, while a small number (10% and 5%) of *Sili* raised rabbit and cattle, respectively and only 10% *Sili* purely raised native pigs. All livestock except rabbit were raised in traditional manner without any input at all. The animals were left to roam around to find their own feed for the whole day and were returned to their pens in the late afternoon. The native pig in this area is very special for the livelihood of the community compared to other animals due to its function. The Dani tribe considers pigs, which equate to wealth and social importance, the most important living creatures besides people [25]. Many cultural interactions involve payment of pigs, often in the form of reciprocal obligations. Traditionally, most pigs are saved for ceremonial purposes and are tended primarily by women and children. Great pig festivals, involving the mass slaughter of pigs and the use of sacral objects, including sweet potato tubers, take place about once every five years, and pig jawbones are maintained in the men's traditional houses (*pilamo*) as the recorded history of these events.

Majority (90%) of the farmers raised native pigs while the rest (10%) raised cross-bred pigs. Aside from being tastier and having a firmer lard texture than cross-bred pork, raising native pigs has been a tradition inherited from their ancestors for hundred years. The farmers also realized, though that the body conformation of cross-bred pigs are bigger than that of the native ones.

Population of pigs including the native pigs decreased from the time of the expansion of the administrative territory which started in the whole Central Mountain Area (in the year 2002 up to 2008) and also in the all Papua Land/Provinces. This situation became worst when the incidence of Hog Cholera emerged and increased in 2005. Table 7 shows the pig population in the regency over the last 10 years.

Piglets were the majority of this population (31.48%) raised by farmers, followed by sows (19.84%), growers (18.38%), barrows (14.01%), gilt (11.30%) and the least was boar (5.01%). The number of piglets dominated this class of pigs and has the widest range of age from 0 to 5 months old. The average number of piglets raised by farmers per *Sili* was 9 heads with at least 4 heads as the minimum and 20 heads as the highest number. Sows were the second largest group of pigs raised by farmers since they were kept as stock animal in the herd and were never culled unless when in an emergency state. For some farmers “no sow means no pigs” (*pers. comm.*). An average of two sows was maintained by every household head for breeding purposes. The number of pigs per *Sili* mainly depended on the number of wives in the *Sili* as was frequently observed especially for sows because

Table 4. The breakdown of total population of native pig in the four study areas in Baliem Valley, Jayawijaya Regency.

Population (heads)	N	Proportion	Mean \pm sd	Min	Max
Sow	218	19.84	5.15 \pm 1.894	2	10
Boar	55	5.01	1.38 \pm 0.667	1	4
Barrow	154	14.01	3.85 \pm 1.847	1	11
Gilt	124	11.30	3.10 \pm 1.446	1	6
Grower	202	18.38	5.05 \pm 3.01	2	13
Piglets	346	31.48	8.65 \pm 4.823	4	20

Every wife was responsible for keeping the sows for the sake of the whole family's needs. In this study, the highest number of sows per *Sili* was 10 and these were owned by a family in a *Sili* with 6 wives. In a research done by [26] in Papua Province. It was revealed that in upland areas, including Wamena, in Jayawijaya Regency, most farmers (69.4%) kept one sow per family because they could not afford to provide feed for more, while in the lowland area of the study, he had found the same result wherein 78.1% of the farmers can only keep one sow per family. In the area of study, barrows were kept for purposes of customary ceremonies. Every year at least one barrow was culled for customary and cultural activities such as mass marriage (*Maue*) and/or the feast of fertility. Barrows were held in slightly higher numbers compared to gilts for customary ceremonies such as for funeral purposes

because the value of barrow for such activities is higher than the gilt while boars were kept only in very small number for breeding. In this research, the classification of native pig breeds is totally different from that recommended by all pigs production authors/experts. The classification of native pigs in this research was based on traditional management practices using traditional native pigs produced by the local farmer for many generations [27]. Table 9 presents the classification of native pigs by age and weight in the study area compared to that recommended by authors in modern pig production systems.

Table 5. Comparison of age classification between the native pig and commercial pigs.

Native Pigs			Commercial Pigs ¹⁾		
Class	Age (months)	Body Weight (kg)	Class	Age (d/m)	Body Weight (kg)
Piglet	0 – 5	1 – 16.5	Piglet	0-1.2	2 - 5
Weanling	None	-	Weanling	1 - 2	6.5 – 20
Grower	6 – 8	18 – 31	Grower	3 – 4	30 – 55
Finisher	None	-	Finisher	5 – 7	60 – 100
Gilt/Barrow/Boar	9-11	35.5 – 52	Gilt/Barrow	8 – 9	100 – 110
Barrow/Sow/Boar	≥ 12	≥ 59	Sow/Boar	≥ 10	≥ 110

1) Arganosa, 1989

Table 5 shows that there were no weanlings as well as finishers presented under the traditional practices since the weaning age of native pigs in this area is 4 – 5 months. The farmers culled (sold or consumed) their animal at any time and at any age/class. There were no specific time and age or class for culling in their traditional practices since the main purpose of raising pig is for social/cultural activities and not for economic or profit orientation.

Several terms have been given to the native pigs in Baliem Valley to stress on their importance to the lives of the people in the community. Sometimes dubbed as “the life of people” because of their “no pig no marriage” culture, some considered pigs as “the heart of the people” because of the many important roles pigs play in their social life [3,16,17]. Without pigs, the people could not be involved in social activities. Pigs are the symbol of power. A man could not speak much in social/ceremonial meetings if he had less pigs compared to other men. Pigs are always the basis of solving any social problem. Aside from the social aspect, pigs provide big positive impacts due to their contribution to the family’s income generation. All the farmer respondents stated that their main purpose of raising native pigs was to meet their socio-cultural needs, followed by consumption, and the last purpose was for sale [12,16,27,28]. Pigs are always involved in any Dani people traditional events such as marriages, conflict resolution, and funeral [29]. In fact, the farmers realized the financial help they could get from pig, especially for their special and urgent needs. Based on this firsthand observation, it could be said that pig is a “kiosk”. It could be a big or a small kiosk depending on the number of pigs being raised since it could give farmers some money any time they need extra funds. Indigenous pigs are still dominant as sources of meat in some rural areas in Africa [16]. Pigs are raised as a cash crop that can be sold anytime there are shortages or unexpected needs of the family arise.

The length of experience in raising pigs varied ranging from 10 to 41 years. Most of the of *Sili* (30%) had been raising pigs for 15 - 20 years, seven *Sili* for 27 - 32 years while six *Sili* had been raising pigs for 21 – 26 years. Only five *Sili* had at least 9 – 14 years and more than or equal to 33 years of pig raising. As shown in Table 5, 50% of *Sili* composed of household heads with age ranging from 46 – 55 years old. It indicates that most of them started farming enterprise at the age of around more than or equal to 20 years old when they were married or at the stage of building their own family. Historically, native pig was the first native animal raised by local people in the area for ages as stated by [30]. Archeological and paleontological evidence suggest people have lived in the New Guinea highlands for as long as 30,000 years. Furthermore, they have practiced agriculture for about 2,000 years, raised and bred pigs from Asia for at least 1,000 years, but cultivated sweet potatoes from South America only in the past 300 years or so. A picture emerges in this century of indigenous peoples with

Stone Age implements almost exclusively cultivating a single crop - sweet potatoes, and raising a singular animal - pigs. The former constitutes the staple diet of both humans and pigs, while the latter constitutes the basis and currency of a complex social exchange networks.

Labor force in this study area can be considered as an informal labor in agriculture work since the farmers (men and women) who worked were unpaid, unstructured, and unregulated. It is composed of father, mother, children (son and/or daughter), and sister(s)/brother(s) and parents from both family sides. The farmer and his wife (wives) were the main labor force for their own on-farm activities and were supported by other family members as long as they are in good health (sisters/brothers or parents) and have reached a certain age to handle the work (for children). As shown in Table 6, the farmers and their wives in 26 (65%) *Sili* worked on their on-farm activities with the support of their children, sisters/brothers, and parents. This indicates that most of the *Sili* in this study area were composed not only of the nucleus family but also of extended family, and the members of this extended family were considered sources of family labor force. There were five (12.50%) *Sili* that involved men (husband), women (wife/wives) and the children in their farm activities and four (10%) *Sili* were also supported by their parents, while two (5%) *Sili* had a family labor force consisting of husband, wife/wives, and their sisters/brothers [16,17,31–33]. Only one (2.50%) *Sili* had husband, wife/wives, and parents, as well as husband, wife/wives with children, sisters/brothers as their family labor force. Family labor force in the study site mostly depended on the composition of family members. The children, especially girls, were usually allowed to help their parents once they reached the age of 12 years (*pers. comm.*). The parents, on the other hand, worked on the farm as long as they are still strong and some of them (especially the mothers) were already 70 - 73 years old. For years, family labor force is one of the vital issues in this integrated production system since women (wife/wives) were given bigger burden compared to men (husband) in terms of time spent for on-farm daily activities.

Table 6. Native pig management practices per *Sili* in Baliem Valley, Jayawijaya.

Practices	N	Percent
Rearing System		
Combination range and confinement	37	92.50
Confinement	3	7.50
Type of Feed		
Sweet Potato Root and Vines	37	92.50
Mixed of sweet potato + rice bran + tofu by-product	3	7.50
Frequency of Feeding		
Once a day	8	20.00
Twice a day	31	77.50
Thrice a day	1	2.50
Practice of Stock Selection		
Yes	40	100.00
No	0	0
Basis of Selection		
Fast growing + Healthy	33	82.50
Breed + Prolific Performance	7	17.50
Source of Stocks		
Neighbor	2	5.00
Market + Previous Stocks	6	15.00
Market + Relatives + Previous Stocks	32	80.00

4. Discussions

4.1. Native pig management practices

Management practices of the Dani people in Baliem Valley for sweet potato-native pig farming system are unique. These practices are not found in the whole Papua Land even in the Central Highland of Papua where the Baliem Valley is located. Several closely-related households live in a *Sili* sharing all resources together as one family. In each *Sili* lives a chief who leads the whole households with an arrangement called *Sabokhogon* which means “one for all and all for one”. These traditional practices brought about a common management system called Communal Management Practices which is applied for several families living together in one compound (*Sili*) and are considered as one family.

The management system for pig production in Baliem Valley is extensive, as pigs are let out in the morning and allowed to wander during the day, grazing in the shrub and fallow fields up to the forest and penned at night, with feeding of sweet potato roots and vines. Range system is the most common practice used in the whole Papua Land when dealing with native livestock including pig. The Dani people let their native pigs to freely roam around every day to find their own feed. In this study, all *Sili* practiced the range system. Pigs were fed with a small amount of feed inside the pen or inside the *Sili* yard called *Silimo* early in the morning (around 6 – 8 am) then let them out from the pen and *Sili* to find other sources of feed available surrounding the *Sili*. The foremost effort done by pigs was to find and feed on earthworms (*omali*) which are their main source of protein.

Pig pens, materials for feeding the pigs, house, land for cropping, and even their income for supporting their children’s and some other needs were commonly shared. Labor force is especially for off-farm activities such as clearing the planting area, building the fence surrounding cropping area or setting the bedding for the crops. Several Dani families live together in one *sili*. They describe their arrangement as “*sabokhogon*” which means “one for all and all for one” because they live and work together as one *sili* unit led by a chief called *Kepala Sili*.

Some household heads complained that they could no longer work as much as they did several years ago although they still have the same resources (*pers.comm*). In human capital theory, productivity is high and increases at younger ages, with a diminishing increase at more mature ages and a possibility of decline at older age [7,11,34]. Age indirectly plays an important role in farming activities because it allows farmers to be receptive to new ideas [17,28,35–38]. On the other hand, age of the wives of all *Sili* varied from 30 to 48 years old with 39 years old as the average age. The age of most (70%) of the wives belonged to the active age of 36 – 45 years old while 30% were in the younger and the older age brackets (46 years old and above) (13, 40, 41). The age difference of females to males was around 10 years younger. This would mean that the wives will still have longer time in farming than the husbands. In terms of human resources at farm level, women in this area could be considered as the focal point of farm activities since most of them are still young up to middle age. The younger to middle age people tends to adopt technology much easier and faster than older ones [34,35,41].

Very large *Sili* size was common in this study area because one *Sili* could have more than one household with more than one wife, aside from the fact that almost all *Sili* were composed of extended family (parents and/or sisters and/or brothers and/or uncles and/or aunties). These extended family members were considered as family labor force in the farm activities. This idea was supported by a research done by [9,17,34,42,43]. In Izmir, Turkey where family members are the family labor force that could play a part in decision making inside the household. The small number of family members indicates the small family labor force available and this might also have an effect on their decision to expand the farm size and diversify crops.

This amount should be enough to support the daily needs of the whole family members in a 17-member household. With this amount every member will get only US \$ 0.86/day. This data shows that the monthly income of every *Sili* was very low and that the farmers should be encouraged to look for off-farm and non-farm activities that could increase their income. Manufacturing hand-made traditional bags, locally known as *Noken*, is another promising non-farm activity that could be maximized as sources of income by farmers especially the wives. These bags are also used during certain

customary/traditional events and could fetch a very good price of IDR. 100.000 to IDR. 300.000 depending on the materials used, size, and design. According to [44], the productivity of non-farm enterprises rises with the educational levels of family workers involved. The more educated household members have comparative advantages in non-farming, which is consistent with labor allocation in the field.

Lack of education brought about the very limited source of income. Men with higher education background were preferred over women to get non-farm income. Most of the farmers depended only on crop production as source of income and had no off-farm and non-farm income. Off-farm and non-farm activities were hardly considered by both household head and his wife/wives as other source of income needed to increase family income. Diversity of source of income in many cases will depend on the farmers' level of education which encourages movement into more remunerative non-farm work, thus increasing household income. Education can allow the likelihood of success in every venture and by doing these, the diversity of the household's source of income may reduce risk and improve economic security [35,45,46].

The large number of beddings in one planting season in each *Sili* is an indication that the farmers and their family tried to make sure that their crops, especially sweet potato, can supply enough food and feed for the family members and pigs for the whole year, respectively. In addition, more production of sweet potato will also support the family income. The sweet potato production system is designed to supply fresh harvests all year-round. Households maintained several beds at different stages of development as well as mixtures of cultivars in each bed to ensure supplies. From 34% of Dani *Silis* (from the sample of 190 Dani *Sili*) used sweet potatoes mainly for human food and only 2.1% for selling. It further concluded that sweet potato is cultivated in this area mainly for food and feed security.

5. Conclusions

The finding of this research was household/*Sili* was 2-3 family, ages 46-55 years, *sili* size was 11-16 (35%), monthly income 1-3 millions/hh, source of income derived from integrated farming systems, crop grown 7-9, bedding was old and new shapes, livestock reared dominated by poultry, native pigs 90%, experience in raising pigs 1-20 years, and piglets production was 346 heads. Pig farming practice dominated by free range and confinement and feed offered twice/day using sweet potatoes root and vines. Breed sourced from market, relative and previous stocks was selected using indicator of fast growth and healthy.

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