

20. Poverty alleviation and food security through improving human-pig-sweetpotato systems in Papua, Indonesia

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Background

Food shortages and malnutrition in Papua, Eastern Indonesia, continue to be major problems. They have become particularly severe since the drought caused by El Niño in 1997. Sweetpotato is of the utmost importance in the diet of the local residents, accounting for 90% of daily diet in many areas, with some estimates calculating per capita annual consumption in Papua at nearly 100 kilos. Orange-fleshed sweetpotato has the additional advantage of reducing Vitamin-A deficiency, which used to be prevalent in Indonesia. The government's attempt to eradicate this deficiency by distributing Vit-A capsules has not been effective or sustainable for the out-flung eastern islands, including Papua. Vit-A rich sweetpotato provides a better alternative to address this deficiency more extensively and sustainably in Papua as sweetpotato constitutes the major part of the daily diet. The crop also accounts for up to 100% of the pig feed in Papua and pork is one of the important sources of protein. In 2000, the human population of Jayawijaya District was 400,130 in 2000, while in the same year the number of pigs in the District reached 351,239 (BPS, 2000). Research into the improvement of the current sweetpotato-pig system represents an opportunity to address the integrated problems of adequate and nutritious supply of staple food for people, sufficient feed supply for pigs and the contribution of pigs to human protein intake and income generation.

Income generation is increasingly important for the peoples of Papua as they become more bound up with national markets and linked to the global economy. The road that is nearing completion between Jayapura, the coastal capital of Papua, and the interior Baliem Valley, will shortly accelerate the linkage of mountain peoples with these markets. Pig-raising has the potential to play a significant role for households in income generation since they demand such high prices (a mature pig can sell for 6-7 million Rupiah). In the indigenous cultures of Papua, pigs carry significant social and cultural, as well as financial, value.

Under current practices associated with the sweetpotato-pig system, pigs have a very slow growth rate and it commonly takes 3-5 years to bring the pigs to maturity of 80-90 kg in Papua (compared with 4-5 months in Vietnam, for example). Many factors of the pig-raising practices contribute to this slow growth, but lack of protein in the pig diet is one of the major contributing factors. For example, in Europe difference of even 1% protein makes pigs grow up to 5% slower and pigs fed diets containing 11% protein will take 20 to 40 days longer to reach a weight of 100 kg compared with pigs fed diets containing 15% protein (Cargill, personal communication). Previous research in Papua New Guinea also indicated similar results with native species of pigs raised in the highlands. This limits the potential of the system to generate economic, nutritional, survival, or symbolic value. Taking fully into consideration the social and cultural contexts of these sweetpotato-pig systems, there is opportunity for technical improvement that can lead to increased pig growth and greater income generation for households from pig sales. It is envisaged that this improved swine productivity could also contribute to greater social and cultural dynamism in rural communities as probably occurred when they shifted from yam-taro to sweetpotato based-agricultural systems over four hundred years ago.

Pig management includes improved nutrition status by balancing the diet, added nutrition in processed sweetpotato vine and roots, improved management and husbandry of pigs, disease management, and regular feeding regimes. Experiments in Vietnam have shown improved pig growth and economic efficiency simply by balancing the pig diet (Peters, 1998) and by fermenting the sweetpotato vines (Peters, 1999). There are various ways of fermenting sweetpotato vines to improve nutritional value. The trials in Vietnam showed that vines fermented with sun-dried chicken

manure increased crude protein level by 25-41% and daily weight gain (DWG) from 431 to 554 grams (29%), while reducing the cost of per kg weight gain by 34% (Peters et al., 2001). A feeding trial in Tonga also found that adding protein in the form of coconuts to the diet of pigs fed on cassava based diets, supplemented with green forage, increased growth rates by between 4% to 9% in village pigs crossed with native breeds. Adding meat meal or fish meal increased growth rates by 15 to 20% over the traditional diets (Cargill, personal communication). It is expected that the increased protein through sweetpotato varietal selection and processing will contribute to increased growth rate.

In 2001, the International Potato Center (CIP), together with various Indonesian and Vietnamese research institutions and the South Australian Agricultural Research Institute (SARDI), embarked on a three-year project (till December 2003) to study and improve sweetpotato-pig production systems in Papua Province of Indonesia and Vietnam. The Australian Center for International Agricultural Research (ACIAR) provided essential funding for the project. The goal of project is to alleviate poverty and increase food security by improving the human-pig-sweetpotato system from a systems perspective, with the following specific objectives:

1. To assess, characterize, and analyze the existing human-pig-sweetpotato production systems in Papua within the overall household economy in order to understand types of systems, their relative importance and their major constraints (Assessment study).
2. To improve sweetpotato-based production and stable food and feed supply with emphasis on selection for dual-purpose and forage feed varieties, drought- or frost-resisting varieties for pig feed in Papua and Vietnam, and vitamin-A rich varieties for humans in Papua (Sweetpotato breeding and selection).
3. To diagnose pig diseases and review literature on such systems and subsequently design modifications to the existing grazing-foraging management systems used in the Baliem Valley, Jayawijaya District, Papua (Pig disease survey and management).
4. To enhance productivity and efficiency of pig growth by nutritional improvement with locally appropriate technology and disease management with various levels of confinement methods those are acceptable to the local farmers in Papua (Pig management).
5. To improve on increasing the efficiency of indigenous, integrated, pig-raising systems oriented to subsistence in Papua (Strengthening indigenous systems).

Around 80 to 90 percent of the project activities will be carried out in Indonesia, with the remaining in Vietnam or Australia. This paper reports on the on-going and planned project activities in Indonesia.

Activities Accomplished in 2001

Literature review

A comprehensive literature review was conducted in 2001. The report was a review of some of the English-language literature relevant to understanding and improving the sweetpotato-pig systems primarily in the Baliem Valley of Papua Province, Indonesia. While there is a substantial body of literature on both sweetpotatoes and pigs for the island of New Guinea, most of the literature deals with either sweetpotatoes or with pigs separately, and much of the literature is based specifically on research conducted in Papua New Guinea. There is a gap in addressing the integrated nature of the

sweetpotato-pig livelihood systems, particularly those present in Papua. This review was an attempt to bring together the research literature on these two components of agriculture and animal husbandry in the lives of the native peoples of Papua. In order to enhance overall understanding, a considerable number of reports and publications from work in Papua New Guinea were included. One of the important considerations of this review was to highlight the implications for research to be undertaken by the International Potato Center (CIP) and its partner institutions under the special project funded by ACIAR.

The review, particularly the section on “Implications for future research”, provided a comprehensive basis for designing the socio-economic diagnostic studies, setting sweetpotato breeding and selection strategies, and planning for future directions of pig production improvement.

Assessment studies

Based on the literature review, an individual survey and a group survey were designed to assess the changes that have taken place since the 1960s when the most comprehensive reports were available concerning sweetpotato cultivation and pig production and significance in the Baliem Valley. The surveys were conducted in seven villages and all the interviews were conducted by the Dani interviewers. Male and Female interviewers from each village were selected and trained to conduct these surveys. In addition to the surveys, a self-recorded time allocation study (of men, women, girls, and boys), food and feed consumption study, and field pest and disease observations were conducted by a sample of Dani villagers. All the participants received training and materials needed (clock, pencils, datasheet, clip board, flash light, and scale) in order to record their own daily activities and daily food and feed consumption. Pests and diseases were observed in the field in relation to the cultivars, the soil conditions, and the weather conditions. These activities are summarized below in Table 1.

Sweetpotato breeding and selection

On-station trial for human consumption

This trial was conducted at the Jayawijaya Agriculture Experiment station in Holima using a Randomized Complete Block Design with 3 replications of 40 clones (15 clones from CIP + 15 clones from Research Institute for Legumes and Tubers (RILET) + 10 local cultivars with potential for good taste and orange flesh). Twenty-five plants of each clone were planted using the mound system. Planted on October 22, 2001 and it was harvested after 6 months later on April 16-17, 2002 with the participation of the farmers who subsequently participated in on-farm trials. None of the trial results is currently available, so cannot be included in this report.

On-station trial for pig consumption

Similar to the trial for human consumption, this trial was also conducted in Jayawijaya Agriculture Experiment station in Holima under Randomized Complete Block Design with 3 replications. Using 40 clones (15 clones from CIP + 15 clones from RILET + 10 local cultivars with potential for high total dry matter content). Each clone consists of 25 plants and planted in mound system. Planted on October 22, 2001, it was harvested after 6 months later on April 16-17, 2002 with the participation of the farmers who will participate in the subsequent on-farm trials.

Seedling selection for both humans and pigs

This trial was conducted in Napua and Tulem villages in the Baliem valley. The trial in Napua was planted on October 25, 2001 while the Tulem trial was planted on December 14, 2001. The

experiments were arranged as an observational trial without replications using the seeds from 24 mother parents. The number of clones from each mother parent was different depending on the number of successful seedling growth (the number varied from 25 to 300). Each plant in the experiment is a separate clone since sweetpotato is an open pollinated crop and each clone possesses different phenotype. The plants were harvested after 6 months.

Hybridization of sweetpotato breeding clones

This trial was conducted at RILET in Malang, East Java. The purpose of this hybridization was to create high genetic variability of Irian Jaya cultivars. Ten Irian Jaya cultivars were crossed with ten improved variety/breeding lines of RILET and CIP. After hybridization the F1 progenies will be planted in Irian Jaya for yield and root quality performance evaluation. Currently, the hybridization (crossing) is being conducted in Malang to produce as many F1 seeds as possible.

Pig production improvement

Effects of parasite powder on weight gain

The purpose of this activity was to examine the effects of parasite burden on weight gain. Pre-packaged parasite medicine for piglets of 10-15 kg were sent from Australia and these medicines were given to the treatment pigs. Due to postal delay, the parasite powder was not received in Wamena until January, 2002. The trials began February 1, 2002. The pigs were weighed initially on February 1 and again on March 1. Each month, the treated pigs were given powder for 7 consecutive days (from the 1st to 7th) to treat parasites. Two parallel trials were conducted: 1) one in Wamena at an NGO (Yayasan Obambo) station, and 2) one in three villages—Tulem, Siepkosi, and Napua. Due to the death of a few pigs in Napua and Yayasan Obambo, we lost access to weighing these pigs. From April 1 onward only pigs in Tulem and Siepkosi continued to be treated and weighed. The results showed positive effects of the treatment in both the villages at the Yayasan Obambo (Table 2).

Feed Sources—Worm farming and high-protein grasses

Sweetpotato, worms, and grasses are the three components of pig diet in the Baliem valley. Pigs waste much energy traveling long distances to look for worms and in the process may also pick up parasites. If worms can be farmed in the compound and be fed to the pigs, and combined with grasses with the `laleken`, this may have some positive effects on pig growth. A simple worm farming technique was tried on a farm in Tulem and will be tested in the indigenous pig raising system in 2002.

High protein forage grasses, *Paspalum* and *Stylo*, were planted in a few sites in the villages to see if: 1) the grasses will grow well under local conditions, 2) the pigs like the grasses, and 3) the pigs will not root up the grass before they can establish. Grass seeds were distributed to various villages in sites both close to and far from the principal road.

In order to compare the nutritional value of the introduced grasses to the grasses currently consumed by the pigs, seven types of local grasses foraged by pigs were collected and analyzed at Balitnak in Bogor, West Java (Table 3). If native grasses are found to have high protein content, an attempt will be made to domesticate them, along with the introduced forage grasses.

Activities Currently Underway or Planned for 2002

Assessment studies

Time allocation, food and feed consumption, and field observations were carried out in October-November 2001 and it was planned to be repeated again approximately six months later in order to examine the possible seasonable variations in field situation, consumption patterns and daily activities. The same participants were asked to record their own daily activities (7 days) and food and feed consumption daily for one week (10 days) and the field observations (every 2 weeks).

Sweetpotato breeding trials

Farmers who participated in the subsequent on-farm trials were invited to come to the on-station trial harvest in order for them to evaluate the 45 clones. Farmer-participants included one man and one woman farmer from each of villages chosen for the on-farm trials. Out of the 20 best yielding varieties, roots were given to them to cook in order to determine which ones would be acceptable for human food and which as pig feed. Based on their evaluation, planting material from this on-station trial was provided for on-farm trials in Moai (low land), Sinatma (medium elevation), and Napua (high land). A follow-up on-station trial was established at Tulem while an observation trial was planted at Siepkosi.

The three on-farm trial sites were selected as they represent three different altitudes—Tulem stands at the same elevation as Wamena at about 1,200 meters, Napua is a high elevation site in the foothills of the mountains. Sinatma is a mid-elevation site higher than Tulem but lower than Napua. So far we have not yet established the exact altitude of these sites without an altimeter. This will be rectified soon when an altimeter will be available to establish the exact reading on the altitude.

The following table (Table 4) is a summary of the April-October, 2002 on-farm trials. The October-April, 2002/2003 on-farm trials will remain basically the same.

Pig production and development

Table 5 is a summary of activities planned for pig production and development. The parasite trial, as explained above, will continue in Tulem and Siepkosi only. The water intake and feeding trials will be conducted by the Jayawijaya Livestock Office (JLO) in Wamena during a period of five months. The water intake trial examines the growth response of local pigs to sufficient water intake as it appears that most pigs are generally not provided with sufficient water. CIP's research in Vietnam on sweetpotato root and vine fermentation has shown much promise in improving pig production and the vine fermentation will be tested at JLO-Wamena to examine the response of the local pigs to fermented feed. The postmortem examinations will be performed in a week in October 2002 at the laboratory of JLO-Wamena. The purpose of this disease survey is to document and understand the parasite burdens present in pigs in the Baliem Valley. Literature also will be reviewed to increase knowledge and understanding of management systems used to control and reduce parasite burdens in pig grazing and foraging systems in tropical and temperate climates. Based on the postmortems and literature review, modified grazing and foraging management systems will be designed to improve pig growth via better management practices that reduce disease and parasite burdens in growing and breeding pigs.

Modifying indigenous pig system trial

While pigs roam free and may destroy sweetpotato gardens at will, the Dani farmers must build heavy fences around all their gardens to keep pigs out, paying a high price for material and enduring heavy labor. While the pigs roam free, they consume human feces at will and may pass diseases back to human later when the pork is consumed by humans. While pigs roam free and far away from the farm compound, the small ones may be easily stolen because the owners have no way of guarding them. But the Dani people seem at a loss as to how to deal with this problem since the major constraint is the exorbitant cost of building hardwood fences, which must come from the faraway forest, for large fenced-in areas. Pigs cannot be confined in the pens during the day because they

must look for food for themselves since the Dani can only feed them sweetpotato once a day, in the evening when the pigs return to the farm compound. During the day the pigs must forage for weeds and worms to supplement the sweetpotato. To confine pigs in pens 24 hours a day as other places in the world would require changes in Dani's whole way of life; while at the same time the current situation results in excessively slow growth, diseases both in humans and pigs, and conflicts among neighbors. Instead of proposing the drastic measure of confining pigs in pens all day, a modified pig production system will be designed and tested that will hopefully resolve some, or all, of these problems without demanding major changes in the traditional way of life.

The modified pig production system will have the following points built in the design:

- To separate the places of defecation of humans and pigs in order to break the chain of diseases.
- To plant *Gliricidia* or other agroforestry species as live fences of the `laleken` so that the leaves can be used as pig feed while the fast-growing tree can be cut for firewood.
- To plant high protein or high starch crops, such as *Paspalum*, *Stylo* and Jerusalem artichoke inside of the `laleken` as forage grasses for pigs.
- To grow worms from compost as another source of feed for pigs.
- Pigs will remain in the `laleken` and eat forage grasses and worms during the day and return to the pigpens at night.
- A water container and a pool will be provided in the `laleken` where pigs are kept—the former for drinking water and the latter for pigs to wallow.
- The `laleken` will be separated into two paddocks—while one is being grazed, grasses are growing in the other one.
- The improved pigpens will be designed once the max/min temperature data from the current pigpens have been recorded by farmers.

Based on these considerations, the modified system is shown in Figure 1.

There are four possible advantages of this modified, closed-in system:

- To separate human feces from pigs in order to break the chain of diseases
- To keep pigs from wasting too much energy on searching for grass and worms
- To keep pigs from being stolen while roaming around
- To keep pigs from being harmed when entering a neighbors' home site or garden
- To keep pigs out of the home garden site
- If all the pigs (in the village) are kept inside the `laleken` there would no longer be need to build expensive and labor-intense fences to keep pigs out.

Summary

The Baliem Valley of West Papua has a distinct human-sweetpotato-pig system, which requires extensive assessment before appropriate interventions can be designed. Thus, the assessment conducted in 2001 provides a guide for the subsequent action research, in addition to shedding light on the changes that have occurred in the valley since the 1960s. Improvement of sweetpotato, the most important staple food in the valley, has the potential to contribute to food and feed quality and security. Formal on-farm sweetpotato breeding and selection trials, which had never previously been done in the valley, are underway to assess sweetpotato clones from the RILET and CIP breeding programs in collaboration with local farmers. Improved forage grasses are being tested to investigate their feasibility as pig feed sources within a confined area so that pigs do not need to roam around free while risking being stolen or destroying gardens. Live fences will be tested as a way of establishing a confined area for pig foraging, as currently the major constraint to setting up a fenced-in area is the cost of wood for fencing. Worm farming is being examined as a more efficient means of providing protein within the confined area so that pigs will not lose the high protein feed that they normally secure from free roaming. Finally, health and disease management is an important issue in

pig production; disease survey and interventions are underway in order to determine relevant intervention strategies for animal health improvement.

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Table 1. Assessment studies conducted in 2001

	Individual survey	Group survey	Time allocation	Food & feed consumption	Field observation
Sampling	16 men, 16 women per village, 7 villages	2 groups of catholic & 2 groups of protestant each village, 7 villages	4 people ^a per village in 7 villages for 7 days	3 home compounds per village in 7 village for 10 days	7 villages every 2 weeks for 4 months
Purpose	Understand general HH information, SP cultivar, cultivation, and uses, food & feed sources, and pig feed & management.	Obtain group opinion on sweetpotato cultivation and uses, and pig health and management.	Understand division of labor, time allocation, labor availability and general HH activities.	Examine diversity and sources of food, food security, and feed quantity.	Identify Pest & diseases in relation to variety, weather, season, and farmers' fields.

^a A man, woman, girl, and boy recording the allocation of time on various activities each day in order to understand the division of labor and time allocation.

Table 2. The average monthly weight gain of the pigs treated with parasite powders and those untreated in the villages and at the Yayasan Obambo (kg/month)

	Treated pigs	Untreated pigs
In the village	3.3	2
Yayasan Obambo	-1.9	-3.6

Table 3. The nutritional value as pig feed of seven types of grass currently foraged by pigs in Wamena

Name of grass	Water contain	Crude protein	Crude fiber
Girimi 1	8.07	11.81	not enough sample
Yelaga 2	7.77	13.78	28.03
Wurikaka 3	7.70	18.32	30.96
Suwiriwi 4	9.98	10.55	27.77
Lukaka 5	9.46	11.19	26.98
Jagat 6	7.64	6.53	37.69
Dokop 7	10.15	13.80	28.00

Table 4. A list of on-farm trial activities in the Baliem Valley for two seasons in 2002-2003

	2 nd on-station trial in Tulem		Observation trial in Siepkosi		On-farm trials in 3 villages		Hybridization trial in Malang
April-Oct	pigs	human	pig	human	pig	human	
Oct-April	pigs	human	pig	human	pig	human	

Table 5. Summary of activities planned to improve pig management and production in 2002

Activities	Purpose	Treatment	Timetable
Parasite powder trial	To examine the effects of treating pigs with parasite powder on pig growth.	T₁ : without parasite powder as usual T₂ : treated with parasite powder	Feb 1 – April (part of trial terminated earlier than scheduled because some pigs died)
Water intake trial	To examine the effects of providing water for pigs on their growth.	T₁ : do not give water as usual T₂ : give water to pigs twice a day after meal	May 1 – Sept 1, a total of 4 months. Pigs are weighed once a month (5 X)
Feeding trial	To examine the effects of different diet on pig growth.	T₁ : usual feed here at JLO T₂ : balanced feed with fresh SP vines T₃ : balanced feed with fermented vines	May 1 – Oct 1, a total of 5 months. Pigs are weighed each month (6 X)
Postmortems	To investigate the diseases existing in the pigs in Baliem Valley	Perform post-mortems on 30 pigs and buy 15 more samples	One week in Oct

Figure 1. Modifying Indigenous System Trial

