

Improving Small-scale Livestock Production in Developing Countries: The Case of Pig Production in Northern Vietnam

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Abstract

An on-farm pig feed trial in Thanh Hoa Province of Northern Vietnam was conducted to find ways to improve the current sweet potato-pig system by prescribing balanced daily feed ration, replacing sweet potato roots with dried chips, and adding greater quantities of protein supplement. The feed formulation and treatments were based on the results of a survey of current practices in order to take into consideration the local situation. The on-farm trial was conducted in six households under the supervision of the Vietnamese government extension service. The results of the trial indicate that the balanced daily ration and dried sweet potato chips improved pig growth, and the dried chips promoted both better growth and required lower cost per kilogram of weight gain. Greater quantities of protein supplement, on the other hand, added substantial extra cost, which led to low profitability. These results are being tested by a follow-up validation trial.

Introduction

With rising income, food consumption trends in Asia have shifted to increased meat intake. Meat productions often are constrained by feed imports or shortage of feed, and alternatives to large-scale and feed-based livestock production are needed. Sweet potato is an ideal livestock feed because the roots provide a source of energy while the leaves a source of protein, and both can be used in fresh and dried form or fermented into silage (Woolfe 1992). Scott (1991) estimates that 65% of sweet potato output in China goes to animal feed, principally to pigs. Sweet potato production is also substantially linked to pig production in Vietnam (Bottema 1992). In addition to China and Vietnam, sweet potato-pig systems play an important role in the rural economy of many parts of Asia: the Philippines, India, Korea, Taiwan, some eastern islands of Indonesia (Bali and Irian Jaya), and Papua New Guinea, while these systems are also practiced, to a lesser extent, in Latin America and Africa (Scott 1991).

Within the context of sweet potato-pig systems, pigs serve several important functions for the rural households: 1) they generate scarce cash income for rural households through market sales, 2) they provide manure for maintaining and improving soil fertility, 3) they convert the generally undesirable and low-valued sweet potato into highly desired foods or highly marketable commodities, and 4) in the case of Irian Jaya, pigs are the basis of social and economic exchange, and play a pivotal role in local culture (Heider 1979). Thus, this system is practiced by almost every household in the sweet potato-producing regions for these purposes.

Despite the importance of this system for the rural household economy, slow pig growth has resulted in the low profitability of pig raising. Thus, improvements in this system could have wide-spread impact in increasing household income by: 1) increasing individual pig growth, and/or 2) supporting more pigs on the same amount of feed. One potential avenue for improving the system is by adding a protein supplement to the traditional low nutrient-dense diet. Thorn (1993) found that the addition of small amounts of protein supplement—locally-available fish meal—greatly improved the efficiency and profitability of smallholder pig production in the Solomon Islands.

Another avenue is to improve sweet potato utilization methods. Previous research results on the effects of sweet potato as pig feed have shown that dried sweet potato chips constitute a more efficient feed (i.e., lower cost and higher daily weight gain) than fresh roots (Koh et al. 1976). Follow-up research also confirmed that “sweet potato chips properly supplemented with protein are considered an adequate energy source for growing finishing pigs.” (Wu 1980:1261). Additional studies have examined the effect of sweet potato chips as pig feed (Wu and Chen 1985, Wu et al. 1985, Wang et al. 1984) and explored various methods of processing sweet potato chips in order to improve their nutritional value (Yeh et al. 1976-77, Wu 1980).

Following a preliminary survey in various sweet potato growing areas of the coastal plains and mountainous regions in northern and central Vietnam, a sweet potato-pig feed trial was conducted in six households of two villages in Tinh Gia District of Thanh Hoa Province in northern Vietnam. This paper reports the following: 1) findings of the preliminary survey, which were instrumental in designing the trial appropriate to the local situation, 2) goals, objectives, hypotheses, and treatments of the trial, 3) participatory methods for conducting the trial, 4) results of the trial, and 5) planning and design of a follow-up validation trial.

Preliminary Survey

A preliminary survey was conducted during April 1997 in two districts of Thanh Hoa Province (northern Vietnam). Forty households were interviewed and the results were analyzed to determine the appropriate locations for pig trials aiming to increase the efficiency of raising fattening pigs. The findings indicated that Tinh Gia was a location where a trial would be appropriate for the following reasons (Table 1).

1. Tinh Gia is oriented to finishing-pig production, 9 - 87 kg, compared to 13 to 64 kg in Hoang Hoa, which only reaches the beginning of the fattening period. Tinh Gia's interest in pig production coincides with the trial's aim of improving the growth rate and profitability of finishing pigs.
2. Tinh Gia households feed great quantities of sweet potato roots and vines to pigs, 40% higher than Hoang Hoa, but the growth rates of the pigs are only comparable or lower, indicating possible excessive ration of sweet potato.
3. Tinh Gia district is located 0 - 2 km from the ocean and the households located on the coast are engaged in fishing. Unmarketable small fish and small shrimp are commonly used as protein supplement for pigs, but the feeding is sporadic. Samples of both these and other protein supplements were collected locally and analyzed in the laboratory in Hanoi for their nutritional

contents. The crude protein content of salted small fish, according to the laboratory analysis, is 13.23%, fresh fish is 57.98%, and 12.62% for small shrimp (Table 2).

4. In addition to small fish and shrimp, fish sauce residue is often fed to pigs. Many use fish sauce residue only as an appetite enhancer because it is believed to have little nutritional value. But others argue that uncooked fish sauce residue does have its merit in improving growth, in addition to enhancing appetite. Due to its wide-spread use and its speculative effects, the utility of fish sauce residue was worth investigation.
5. Currently both sweet potato fresh roots and dried chips are fed to pigs. The major sweet potato harvest season in Tinh Gia is in May/June during the dry season, which makes it possible to process chips as pig feed.

Trial Design

The results of Koh et al. (1976) trial showed that pigs grew 60 kg (26 - 90 kg) within 83 to 118 days (daily weight gain ranged from 542 g to 778 g), depending on the diet. The preliminary survey results indicated that great quantities of sweet potatoes are currently fed to pigs, but the growth rate (9 kg/month = 300 g of daily weight gain) has not reached its optimal potential. The goal of the International Potato Center (CIP) is poverty alleviation through livelihood improvements associated with its mandated commodities. In this case, the research goal is to determine how to improve pig-raising techniques, by using locally available feed, specifically sweet potato, to reach optimal growth with minimum input through balancing the diet.

In order to achieve the goal, the following objectives were generated:

- To conduct a pig feed trial comparing the effects of a variety of diets on pig growth.
- To calculate total feed cost for each diet and analyze the cost per kilo of weight increase for each diet to determine the most economically efficient diet for raising finishing pigs.

Based on the objectives, the following four hypotheses, generated from literature, previous research, and local conditions, were tested:

- H₁: Replacing sweet potato fresh roots with dried chips promotes better growth.
H₂: Adding small fish as extra protein to the current diet improves pig growth.
H₃: Adding fish sauce residue improves pig growth.
H₄: These alternative diets result in lower cost per kg of weight gain.

In addition to fish and sweet potato roots, the preliminary survey showed that the pig diet normally includes sweet potato vine, maize, rice bran, and some peanuts and rice, all of which are available on the farm and commonly used as pig feed by farmers (Table 3). With this traditional diet as the basic formulation, four treatments with prescribed balanced daily ration were designed to test the hypotheses (Table 4). The four treatments are as follows, with Treatment 1 approximating the traditional feeding practice by standardizing and balancing the traditional dietary elements:

- T₁: Fish (traditional ration) + sweet potato (fresh & chips)
T₂: Fish (traditional ration) + sweet potato chips

- T₃: Fish (added ration) + sweet potato (fresh & chips)
T₄: Fish (traditional ration) + Fish sauce residue + sweet potato (fresh & chips)

Methods

On-farm Participatory Trial

The pig trial was conducted between April 20 and August 31, a total of 133 days. The trial adapted the method developed by Koh et al. (1976) to on-farm conditions. The piglets were weighed for three consecutive days; the average of these three days was taken as the beginning weight and the second day of weighing marked the first day of the trial. The same procedure was repeated as the ending weight and the last day of the trial. During the 133 days of trial, pigs were weighed every two weeks.

Six male pigs for each treatment were purchased (i.e., 4 treatments with 6 replications)—a total of 24 pigs—and placed in six households in two villages. Each of the participating households constructed four individual pens for the four treatments. Prior to the trial, a meeting with the participating women (raising pigs is traditionally women's responsibility) was held during which the women were consulted on feed formulation, construction of the weighing cage, and the weighing schedule. During the meeting, the women were also informed of the purpose of the trial, the meaning of the treatments, the method of feeding, and the importance of standardized method for raising the trial pigs.

As requested by the participating women, the participants were allowed to select their own piglets as long as they followed the weight specification—8 - 12 kg. Once the piglets were selected they were kept in their individual pens for a week to settle into the new environment before the trial began. During this week, they were vaccinated by the local participating extensionists against diseases and de-wormed. Since the women were not accustomed to weighing feed, to ensure precision in feed consumption the local extensionists weighed the daily feed and distributed it to the participating households. The women ground maize, bran, and chips into flour and cooked the flour together with chopped vines, sliced roots (except Treatment 2), grass, and fish. For Treatment 4, fish sauce residue was added in at the end of cooking. The pigs were fed three times daily: 6- 6:30 am, noon, and 6:30 - 7 pm.

Problems Encountered

On-farm trials produce relevant results for farmers, but the logistics can be difficult to control. Some problems encountered during this trial only increased the complexity of the trial, but others have implications for the results of the trial. These problems led to the adjustments in the follow-up validation trial procedure discussed at the end of the paper.

1. *The design of pig pens for weighing.* Most pens were not designed to facilitate opening the gate to allow pigs to walk out directly into the weighing cage. Some did not even have gates and others were difficult to open the gates because of the way the pens were angled. The problem

was even worse when the pens were low which made it difficult to move the cage inside the pen for weighing.

2. *The design of the pens for keeping the pigs.* Three problems were observed: 1) the low walls or flimsy bamboo walls between the pens could not keep the pigs out of each other's pens, 2) the front wall was too low to keep the pigs in, and 3) the pigs got out of the front gate by squeezing through the gaps between bamboo bars.
3. *The design of the pens for health.* A couple of households had pens which had poor drainage, hence the pigs constantly laid in puddles of water. Others had low and thick thatched roofs which made it excessively dark in the pens.
4. *Problems associated with the design of the weighing cage.* First, the two gates on either side were designed for large pigs and the gaps between bars were so big that the pigs routinely ran out through the gaps. Secondly, the cage weighed 13.5 kg and was difficult for the women to carry it from house to house.
5. *Participants' pig-raising habits.* Despite repeated reminders, some would feed the pigs before weighing in the beginning. Initially, upon a few occasions, some would feed extra fish from their fishing trips to pigs. However, the quantity was minimal and all pigs representing the four treatments were fed the additional ration, so no particular treatments were unduly biased.

Results and Discussion

Pig Growth

An outlier from each treatment was dropped (e.g., Treatment 1 pig of household 2 gained 18.3 kg while the average weight gain of the other five pigs was 52.3 kg) and the results were based on five samples of each treatment. Treatments 1 and 2 both reached 11.8 kg of monthly, or .39 kg of daily, weight gain (Table 5), which is higher than the estimated growth rate (9 kg/month) of current practices (Table 1). The women asserted that in the years past, pig growth always fluctuated depending on the incidence of disease, but the pigs never achieved the same growth as the trial. Moreover, the monthly weight gains of Treatments 1 and 2 ranged from 8.8 to 13.9 kg, indicating that monthly weight gain could potentially reach 13.9 kg under favorable conditions (e.g., absence of illness). That since Treatment 1 approximates traditional feeding with balanced daily formulation, the results suggest that balanced feeding contributes to improved growth. The participating women attributed the improved growth to balanced formulation since they normally feed sporadically with whatever feed is available at the farm of any particular day.

When percent weight gain was calculated to adjust for the different starting weights, since the beginning weights were not uniform, Treatment 2 shows higher percent weight gain (533%) than Treatment 1 (477%), despite the same daily or monthly weight gain (Table 5). This result supports the hypothesis (H_1) that sweet potato chips promote better growth than fresh roots.

Treatments 3 and 4, on the other hand, achieved lower daily, monthly, and percent weight gain than Treatment 1 (Table 5), refuting hypotheses 2 and that added fish or fish sauce residue promotes better growth. However, this result may be inconclusive as several Treatment 3 and 4 pigs were reported to have digestive problems, described by the participating women as constipation, throughout the trial period. The women suggested that the problem stemmed from feeding fish to

piglets when they were too young, as they maintain that fish is difficult for 20 kg piglets to digest. They stated that this digestive problem hindered growth because it inhibited appetite, and they recommended that fish be given after the pigs reach 30 kg. This explanation seems plausible since it is inherently illogical that added protein should lead to stunted growth, even if it does not enhance growth. Since the stunted growth may be attributed to the digestive problem, these two hypotheses (H₂ and H₃) were inconclusive.

The women also reported that during the trial there were two periods of intensive heat over 40° C, once for 15 consecutive days and once for 7 days. During these periods of heat, they observed lack of appetite and hindered growth for all pigs. However, this problem is not reflected in daily weight gain (DWG) as all four treatments show steady increase, albeit at different rates, throughout the trial (Figure 1). The steady increase of DWG suggests that heat wave or digestive problem either did not have an abrupt effect on growth, or they adversely affected Treatments 3 and 4 steadily throughout the trial.

Economic Aspects

In addition to achieving higher percent weight gain than Treatment 1, Treatment 2 also required the lowest cost--8,028 VND (US\$ 1 = 11,670 VND)--for one kilogram of weight gain (Table 6). This empirical evidence supports Hypothesis 4 (supported by Treatment 2) that the alternative diet of replacing sweet potato fresh roots with chips requires lower cost per kilogram of weight gain. The market price of pigs (not pork) is 10,000 VND kg⁻¹, which suggests that the per kilogram profit of Treatment 2 is 1,972 VND. However, these feed compositions were formulated based on the available feed on the farm: sweet potato, bran, and rice, which consist almost 70% of the feed, are readily available on farm (Table 7). These feed sources are not usually purchased inputs, but for the purpose of calculating the opportunity costs for the trial, market prices are used. Maize is planted in this area, even though not every household has enough maize production to support 2 pigs. Unmarketable small fresh fish is abundant seasonably, the surplus of which may be dried for feed during the off-season. The local farmers' view of the real profit per kilogram of weight gain far exceeds 1,972 VND because most of the feed sources are not purchased inputs, but rather produced on-farm.

Treatments 3 and 4, on the other hand, required 11,808 and 10,250 VND for one kilogram of weight gain, which are significantly higher than that of Treatment 1. The costs of fish for Treatments 3 and 4 account for more than 20% of the total cost, which make the weight gain economically inefficient. The combination of slower growth and higher cost of per kilogram of weight gain indicates that Treatments 3 and 4 are less efficient and profitable than Treatments 1 and 2.

Conclusions

The objective of the pig trial was to determine the most economically-efficient method of improving pig growth by replacing sweet potato fresh roots with dried chips and by adding protein to the low nutrient-dense diet. The trial results showed that improvements can be made by simply balancing the traditional feeding composition, without adding extra investment. In other words, by building on

the traditional feeding practice, the improvements were achieved without requiring extra cash inputs by utilizing locally available feed resources.

In addition to the use of balanced formulation of daily feed, the results showed that sweet potato chips promoted better growth than fresh roots. Dried chips not only solve the storage problems associated with fresh roots, but also increase the economic efficiency of pig raising. This practice should be encouraged in areas where sweet potato harvests coincide with the dry season, such as in Tinh Gia District.

Due to prevalent digestive problems among pigs of Treatments 3 and 4, the results of this part of the trial may be biased; hence, no definite conclusions on the growth can be drawn. The economics of Treatments 3 and 4, however, showed that the added fish as protein supplement is not cost-efficient since the cost per kilogram of weight gain exceeds the sale price per kilogram of meat. Thus, these treatments cannot be recommended as an avenue for improving pig-raising in the context of Tinh Gia District.

The technical and economic conclusions of this trial have implications for other parts of Asia—China, the Philippines, India, eastern islands of Indonesia (Bali and Irian Jaya), and Papua New Guinea—where there is plenty of sweet potato but shortage of feed sources while demand for meat is rising. Similar trials, adapted to local feed situation, can be conducted to determine the most efficient method of feeding local feed sources for pig production.

In addition to the conclusions drawn from technical and economic aspects of this trial, the method of the trial also needs to be addressed. During an extension meeting held upon the completion of the trial, the repeated praise from the local officials and community leaders was directed toward the on-farm, participatory nature of the trial. The commune leaders stressed that farmers need scientific experiments that are appropriate to local conditions, and which need to be carried out on-farm. The Vice Director of the Agriculture and Forestry Extension Center, Department of Agriculture and Rural Development of Thanh Hoa Province, stated the following:

I am the head of the extension service of the province, but never have I seen a trial like this. The only trials I have seen were on big research stations. I told the farmers that we have scientists coming to help them and they need to follow the instructions of the trial. Even though sometimes the farmers made mistakes, but most of the time they followed instructions well. It is important for farmers, extension people, and scientists to work together. In Tinh Gia, there is a long tradition of feeding sweet potato to pigs, most farmers do not think about how to improve pig growth. Now perhaps they will think more about it.

It was apparent that officials and farmers all found “on-farm” an important aspect of this trial as it addressed farmers needs, constraints, and opportunities.

A follow-up trial was organized to validate the trial results that balanced formulation and sweet potato chips indeed consistently achieve better growth. The on-going validation trial consists of 2 treatments (Treatments 1 and 2) with 20 replications to be carried out in 20 households. For this

trial, the participants are taking more responsibility and weighing the feed daily, under the supervision of the extension service. Thus, a training session was organized to train the participating women to measure and weigh the daily feed. The original six participating women are serving as leaders among the participants and as assistants of the trial. The following alterations were made as suggested by the original participants from their experience.

- Piglets were purchased collectively from a pig farm to enhance the uniformity of the piglets.
- The piglets weighed approximately 15 kg so that they were stronger and healthier and less prone to illness.
- Larger pens and lighter roofs were constructed to allow movement in the pen and more light into the pen.
- Fish will not be fed to the pigs until they have reached 30 kg.
- The trial is being conducted during the fall when the heat has subsided and the pigs are less prone to diseases.
- A veterinarian will be consulted whenever there are signs of illness.

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