



RESEARCH
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Roots, Tubers
and Bananas



Technical report: Effect of Sweetpotato Silage Diets on Performance of Growing Pigs in Uganda

*Expanding Utilization of Roots, Tubers and Bananas
and Reducing Their Postharvest Losses*



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EXECUTIVE SUMMARY

A study consisting of on-station and an on-farm trials was conducted to establish the feeding value of sweetpotato vines-based (SPV) silage for growing pigs. A total of 48 growing pigs were used in the on-station trial. Four different dietary treatments were tested: i) 100% maize-soybean commercial diet; ii) 60% silage and 40% maize-soybean; iii) 80% SPV silage and 20% maize-soybean; and iv) 100% SPV silage. The animals were divided into uniform groups of four and the groups randomly allotted to the dietary treatments in a complete randomized design with three replicates. Feed intake and weekly weight gain were measured and recorded and the information were used to calculate rate of body weight gain and feed conversion ratio. The results from the on-station trial were then validated on-farm in a follow up feeding trial. For the on-farm trials 16 pilot farmers fed their pigs (3 each) with a basal silage diet at free will and supplemented with a concentrate. Pig growth performances were compared with the ones attained by 8 control farmers.

Although sweetpotato silage contained crude protein levels of 17-19%, feeding a sole diet of sweetpotato vines silage resulted in poor body weight gain and feed conversion efficiency. Daily feed intake and daily body weight gain were increased as the level of supplement was increased. The study showed that sweetpotato silage supplemented with 40% maize bran-soybean concentrate can significantly improve performance of pigs under smallholder farming conditions. Therefore, silage can contribute to improving the on-farm availability of feeds thus eliminating stunting observed during the dry season when feed supply is low.

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INTRODUCTION

Market-oriented smallholder pig production in Uganda is growing, but productivity is severely constrained by limited availability of quality and affordable feeds. This study aimed to demonstrate how best to utilize sweetpotato vines in pig feed, through conserving the vines in form of silage and the introduction of improved feeding practices. This would result in sustainable enhancement of small-scaler pig production leading and thus benefit smallholders and other actors along the value chain.

Currently, 1.1 million smallholder households in Uganda (about 5% of the total population) raise about 3.2 million pigs – a ten-fold increase over the past 30 years. Pig production is one of the main sources of income for female farmers in Uganda and women constitute a sizable proportion of pig producers. Growth in demand for pig products is projected to continue to grow, driven by urbanization and population growth, and provides significant and expanding income opportunities for smallholder farmers, in particular women.

The single most important constraint to improving productivity of the current pig system is access to and utilization of low-cost quality feeds. Pig husbandry in Uganda mainly relies on agro-industrial by-products, kitchen waste and simple feeds available on farm. Commercial concentrate feeds are rarely used since they are expensive, not consistently available and of uncertain quality. Not only is the price of concentrate high, but often unavailable in the rural areas where most pigs are kept. Conversely, farmers traditionally access and use locally available cheap feed ingredients such as sweetpotato residues. However, producers are affected by seasonal shortages of these local feed ingredients as well as fluctuations in the availability and price of commercial feeds. Farmers are unaware of technologies to preserve the locally available feeds and the best practices to formulate complete diets by supplementing local feeds with a correct amount of protein-rich ingredients, such as soybean meal, to ensure that a balanced and affordable diet is fed to pigs.

Technologies for preserving sweetpotato vines, such as silage, have the potential to address the need of quality and affordable feeds that are easily accessible by smallholder farmers. Uganda is the highest sweetpotato producer in Africa, and there is strong evidence of the efficacy of pig feeds based on this root crop. The areas of greatest growth of pig production in Uganda coincide with the ones with high sweetpotato production, creating great and immediate opportunities for improving the utilization of this crop. However, the potential for

use of sweetpotato vines has hardly been assessed and exploited. High yielding varieties of sweetpotato are available and in use in Uganda, yet their potential for further development into improved feeds is not known. Non marketable roots can also be used to compound pig diets.

This study was conducted with the aim to assess the performance of pig fed on SPV-based silage and identify if and how to supplement the silage with protein-rich ingredients in order to provide suitable recommendations to small-scale pig farmers.

Objectives

The overall goal of the study was to improve the profitability of smallholder pig production in Uganda and to increase pig production through enhanced use of low cost and locally available sweetpotato vine silage. The overall objective was achieved through these specific objectives:

1. To evaluate pig production and profitability through on-station feeding trials that incorporate sweetpotato vines silage.
2. To validate on-station results at farm level and promote the adoption of sweetpotato vine silage feeding options for smallholder farmers.

Justification

The efficient conservation and utilization of sweetpotato vines to feed pigs in smallholder production systems can help to reduce the feeding constraints arising from the difficulty in ensuring sufficient supplies and the seasonal availability of local feeds coupled with the poor quality, high price and inconsistent supplies of commercial feeds. Sweetpotato vines are susceptible to rapid deterioration and contamination by microorganisms after harvest, some of which are extremely pathogenic. However, it has been shown that by ensiling, the vines can be completely decontaminated and safely used as an alternative feedstuff for a longer period. Increasing the shelf-life of the vines would serve to bridge the feed shortage gap especially in the dry season.

METHODOLOGY

The study consisted of (i) on-station feeding trials to determine the response of growing pigs fed on sweetpotato silage at different supplementation rates; (ii) on-farm trials to validate the on-station results.

Experimental design and treatments for the on-station feeding trials

The experiment was conducted at the MUZARDI satellite station at Kamenyamiggo in Masaka district (Masaka-Mbarara road, 134 km South-West of Kampala city).

Forty-eight Camborough pigs with an average initial body weight of 23 ± 0.5 kgs were used in the study. The pigs were ear-tagged and housed in solid concrete floor pens fitted with water and feed troughs. Four dietary treatments with increasing levels of SPV-based silage were used in the experiment (Table 1). Pigs were allotted to the treatments in groups of four. A Completely Randomized Design (CRD) with three replications was used.

Table 1: Composition of on-station experimental diets

Ingredients	Levels of inclusion (%)			
Sweetpotato vines silage	0	60	80	100
Maize bran-soybean mix	100	40	20	0

For silage preparation, the sweetpotato vines were harvested and spread out to wilt for at least 6-8 hours. The forage was then chopped into pieces of 2.5-3 cm length using a mechanical forage chopper. The chopped materials were mixed with maize bran at a proportion of 5 percent. The material was then packed in tube silos weighing approximately 80-100kg each, tightly sealed and stored in a rat free place. The tube silo was opened after 30 days of ensiling. The detailed formulation of the maize bran-soybean mix used for supplementing the silage is shown in Table 2.

Pigs were weighed at the start of the experiment and subsequently weights were recorded on a weekly basis for 12 weeks. Weight gain was calculated as the difference between the final and the initial live weight. Feed intake was obtained as the difference between the quantity

offered and the quantity not consumed. Feed conversion ratio (FCR) was calculated as feed intake divided by weight gain.

Table 2: Composition of maize bran-soybean mix

Ingredient	Composition (%)
Maize bran	73.7
Soybean	20
Lysine	0.3
Lake shells	5
Salt	0.5
Vitamin mineral premix *	0.5

* Vitamin mineral premix provides per kg diet: Vitamin A-12,500 I.U.; Vitamin D₃-Vitamin K₃-3.0mg; Vitamin B₁-1.0mg; Vitamin B₂-5.0mg; VitaminB₁₂-0.05mg; Nicotinic acid-11.2mg; Calcium Pantothenate-6mg; Choline-0.1mg; Manganese-75mg; Zinc-62mg; Copper-6mg; Iodine-1.0mg; Selenium-0.12mg (Source: Wright Ltd., BASF Group, U.K.; distributed by MTK Uganda Ltd).

For determination of carcass characteristics, two pigs (one male and one female) per treatment per replicate were slaughtered at the end of the growth period to evaluate the slaughter characteristics. Prior to slaughter, pigs were fasted for 16 hours but given drinking water. After severing the jugular vein the carcasses were dehaired using hot water poured onto the entire skin surface and the hairs scraped off. They were then eviscerated and the remaining carcass was weighed and the weight expressed as a percentage of live weight to obtain the warm dressing percentage. Back fat thickness was measured at the 4th rib with Vanier calipers.

Experimental design and treatments for the on-station feeding trials

The on-farm trials were carried out in Masaka and Kamuli districts of Uganda. Masaka lies to the South West of Kampala while Kamuli lies to the Eastern side of Kampala. Both districts lie within the Lake Victoria basin. The areas experience a modified equatorial climate with a bimodal rainfall pattern. The long rains come in March to June and the short rains in September to December.

In each district three sub-counties were selected based on importance of sweetpotato and pig production as well as accessibility. The sub-counties selected in Masaka included Nyendo-Senyange, Buwunga and Mukungwe while, for Kamuli, Bugulumbya, Butansi and Namwendwa were selected. All sub-counties in Kamuli were rural while those in Masaka were urban (Nyendo Senyange), peri-urban (Mukungwe) and rural (Buwunga).

As shown in Table 3, a total of 24 farmers (4 farmers from each sub-county) were selected based on the following criteria: i) willingness to participate in the study; (ii) having a minimum of 0.5 ha of well-established sweetpotato field; (iii) availability of land and labor to plant and manage sweetpotato (iv) owning 1-5 pigs; (v) willingness to allow research staff and other farmers to visit her/his pig unit; (vi) capacity and willingness to keep farm records.

Table 3: Sample

District	Sub-county	No. of farmers	No. of pigs
	Nyendo Senyange	4	12
Masaka	Buwunga	4	12
	Mukungwe	4	12
	Bugulumbya	4	12
Kamuli	Butansi	4	12
	Namwendwa	4	12

Information on household characteristics, farm activities, land use, resources used in pig feeding and constraints to their utilization were collected from each selected household using a structured questionnaire supplemented by on-site observations. Survey data were analyzed using Statistical Package for the Social Sciences (SPSS) software. Participatory methodologies were used during feedback workshops to validate information, build consensus and provide clarifications on the planned research.

The following treatments were randomly allocated to farmers: (1) a basal silage diet fed at free will and supplemented with the maize bran-soybean mix (for 8 pilot farmers in each district); and (2) feeding on a variety of locally available resources as and when they become available to the farmer and according to conventional practices (for 4 control farmers in each

district). To save the farmers from the burden of separating the study animals during feeding, each household had one dietary treatment. The silage was made using tube silo technology and comprised 80% sweetpotato vines and 20% sweetpotato roots. Both pilot and control farmers were trained in animal management and record keeping. All pigs were de-warmed, treated against external parasites and ear-tagged for identification.

Data were collected over a period of 90 days. Farmers and field technicians from local partner organizations (VEDCO and CHAIN-Uganda) were trained by scientists from the International Livestock Research Institute (ILRI) on how to record the amount of feed consumed on daily basis. The ILRI staff regularly monitored accuracy of the data collected. Body weight of the pigs was recorded by research staff after every fortnight. Collected data were entered in Excel, imported into SAS and analyzed using the General Linear Model procedure to compute feed intake and the animals' weight gain and, eventually, to assess the differences between mean values of pig performance given the different feeding treatments.

RESULTS

Results of the on-station feeding trials

Results of performance of pigs fed the experimental diets are presented in Table 4. There were significant differences ($P<0.05$) in feed intake, final weight, daily live weight gain and feed conversion ratio (FCR) among the experimental diets.

Feeding a diet composed solely of sweetpotato vines silage resulted in low growth and poor feed conversion efficiency. As the level of supplement increased there was an increase in final body weight, feed intake, average daily gain and an improvement in feed conversion efficiency. Although the diet with sweetpotato vines silage had levels of crude protein comparable to the other diets, it appears that the balance of amino acids was poor and could not support reasonable growth rates. This is why an improvement in performance was observed when a supplement with a balanced composition of amino acids was administered.

Table 4: Growth and efficiency of feed utilization of growing pigs fed on basal diet of SPV supplemented at different levels

Parameters (n=48)	Level of concentrate supplementation (%)				SEM
	0	20	40	100	
Final wt (kg/pig)	30.30 ^a	56.7 ^a	65.12 ^b	73.64 ^b	2.39
ADG (kg/day)	0.193 ^a	0.225 ^a	0.249 ^a	0.458 ^b	0.42
ADFI (kg/day)	0.98 ^a	1.10 ^a	1.25 ^b	2.01 ^b	0.04
Feed /gain	4.99 ^a	4.43 ^a	4.40 ^a	3.99 ^b	0.11

^{ab} Means with similar superscripts within row are not significantly different ($P<0.05$)

ADG =Average Daily Gain ADFI= Average Daily Feed Intake Feed/Gain=Feed Conversion Rate

Slaughter characteristics are summarized in Table 5. Carcass weight was highest for pigs fed on the sole concentrate diet. All parameters improved as the silage was increasingly supplemented with a concentrate. The weight of the liver and kidney were not affected by feeding silage meaning that there were no anti-nutrient factors in the silage to levels that would lead to increase in the sizes of these organs.

Table 5: Slaughter characteristics of growing pigs fed a basal diet of SPV silage supplemented at different levels.

Parameters (n=48)	Level of supplement (%)				SEM
	0	20	40	100	
Carcass weight (kg)	17.30 ^a	33.50 ^b	40.80 ^b	48.60 ^b	6.90
Dressing percentage	57.68 ^a	59.46 ^a	62.65 ^{ab}	65.99 ^b	4.5
Back fat thickness					
4 th rib (cm)	1.05 ^b	1.10 ^a	1.62 ^b	2.50 ^b	0.13
Liver weight (kg)	0.71 ^a	0.83 ^a	0.85 ^a	0.98 ^a	0.06
Kidney weight (kg)	0.13 ^a	0.14 ^a	0.14 ^a	0.15 ^a	0.01

^{ab} Means with similar superscripts within row are not significantly different (P<0.05)

Results of on-farm feeding trials

Results for the on-farm trials showed that the average ratio of silage and supplement intake was about 60:40. At this inclusion level performances were similar to the ones recorded on-station for 60:40 diet. Most importantly properly supplemented sweetpotato silage outperformed the farmer's practice (Table 6). Less feed was required to add a unit of body weight when a silage based diet was fed. Although not subjected to analysis, farmers observed that the drudgery of looking for feeds was reduced when silage was prepared and used for feeding. This allowed women, who were reported to be mostly responsible for feeding pigs, to devote more time to household chores and other farming activities.

Table 6: Effect of supplementing sweet potato vines silage on performance of growing-finishing pigs

Parameter	Control	60:40	SEM
		Silage: Supplement	
Daily Feed Intake (kg)	1.23 ^a	1.32 ^a	0.93
Average daily gain (g)	144.7 ^b	235.7 ^a	22.5
Feed/gain	6.5 ^b	4.6 ^a	1.6

^{ab} Means with similar superscripts within row are not significantly different (P<0.05)

CONSIDERATIONS ABOUT USE OF SWEETPOTATO SILAGE

Sweetpotato vines have high crude protein (CP) content and should be considered as a valuable feedstuff for growing pigs. However, in growing pigs, the digestibility coefficients of dietary fiber are normally between 0.40 and 0.60 with a wide variation depending on fiber source. The poor performance of pigs on a sole diet of sweetpotato silage can be explained by the high levels of crude fiber that leads to poor digestibility of nutrients, the low level of dry matter and the unbalanced nature of the protein fraction of the diet. The inclusion of fiber-rich sweetpotato vines in the diet reduced the digestibility of CP and organic matter (OM). This is in agreement with studies on inclusion of tropical foliage (Phuc and Lindberg, 2000) and other fiber-rich feedstuffs (Wenk, 2001) in diets for growing pigs. A likely explanation for the reduced digestibility of protein and amino acids in fiber-rich diets is that amino acids are bound to or encapsulated in the cell wall and that fiber will stimulate secretion of endogenous nitrogen. Also, a high content of insoluble fiber in the digesta increases the peristaltic action of the gut and, therefore, reduces the transit time, which may lead to a decreased digestibility (Jørgensen et al., 1996).

The growth performance showed that when the CP of the diet is provided from sweetpotato vines, the daily gain and feed conversion were lower to those of pigs fed with soybean meal, but the performance improved as the level of SPV silage's supplementation increased. This can be explained by the fact that although sweetpotato vines are relatively rich in protein, there is an imbalance in levels of essential amino acids like lysine which become limiting (Woolfe, 1992).

CONCLUSIONS AND RECOMMENDATIONS

- The use of sweetpotato silage can contribute to improving feed availability in smallholder pig farms and therefore mitigate feed shortages during the dry season when supply is low.
- In Uganda, where weather conditions during the harvesting season do not favour conservation of sweetpotato vines by sun-drying, ensiling is recommended for preservation.
- The nutritional properties of the sweetpotato vines indicate that they have the potential to improve dietary protein and amino acid supply in diets for pigs.
- Sweetpotato silage when fed with a supplement of a maize bran-soybean concentrate can significantly improve performance of pigs under smallholder farming conditions.
- Sweetpotato vines can be used as a high protein feedstuff for pigs. However, due to the unbalanced amino acid content, sweetpotato vines (either fresh or ensiled) should be supplemented with sufficient essential amino acids (especially lysine) to improve the nutritive value for growing pigs.

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