SCALING-UP SWEETPOTATO VINE SILAGE TECHNOLOGY: CONSULTANCY REPORT


Mr. Norman Kwikiriza, CIP handing over forage chopper to a Chairperson, Bavubuka Twekembe Group (left) and sweetpotato vine silage production by the same group (right)


Making silage from a mixture of sweetpotato vines maize stover (left) and a cow feeding on sweetpotato vine silage mixed with Rhodes grass hay (right)

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Abbreviations

CIP	International Potato Center
COVID-19	Coronavirus
KCCA	Kampala City Council Authority
Kg.	Kilogramme
ILRI	International Livestock Research Institute
NaCRRI	National Crops Resources Research Institute
NaLIRRI	National Livestock Resources Research Institute
SOPs	Standard Operating Procedures
SPVS	Sweetpotato vine silage
US $	United States Dollar

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Introduction

Sweetpotato is the third most important staple in Uganda. Many farmers who grow sweetpotato also raise pigs, goats, sheep or cattle. Sweetpotato vines have a high crude protein (19-22%). During the sweetpotato harvest, farmers may feed sweetpotato vines, small roots and peels to their livestock, but they face a challenge (Kabirizi et al., 2017): The vines and roots are highly perishable. Around 20% of the total sweetpotato harvest is "waste" (Asindu et al., 2017). The sweetpotato vines are not available during the dry season, when all animal fodder is scarce. Moreover, non-livestock farmers have no use for the vines, which become an environmental hazard.

In order to make good use of sweetpotato residues, strategies that conserve the resources for pigs and dairy cattle during the time of abundance for use during the times of scarcity have already been developed, packaged and tested by CIP; Livestock Research institute (LIRI); Makerere University, Sight Farm, Nakyesasa and Kyakuwa farm, Wakiso district (Mutetikka et al., 2017; Galla et al., 2020). Silage is preserved fodder, produced by fermentation in the absence of oxygen (Kabirizi et al., 2017). The resultant feed is very nutritious for animals, often more attractive than unfermented material. It improves nutrition both by being more digestible and as a result of the fermentation.

Mutetikka et al. (2017) reported that feeding pigs on sweetpotato vine silage supplemented at a level of 40% with a pig concentrate (16 percent crude protein) improved pig growth performance. In another study conducted to assess the effect of feeding sweetpotato vine silage (SPVS) supplementation with homemade dairy pellets (14% crude protein content) on crossbred lactating dairy cattle fed a basal diet of *Chloris gayana* (Rhodes grass) showed improved dry matter intake, milk yield and milk fat content (Galla et al., 2020). Supplementing dairy cows with SPVS at a level of 10% of their daily feed intake yielded a profit of Uganda shillings 1,290 (US $ 0.36) on daily basis. It was concluded that 10% SPVS supplementation of dairy cows results in an increase in milk yield and butter fat.

In Uganda, a number of youth groups such as: (1) MADCO Investment Limited, Luwero district; (2) Bavubuka Twekembe, Wakiso and Luwero districts; (3) Namulonge Sweetpotato Growers, Wakiso district and; (4) The Next Generation Agricultural Entrepreneurs, Makindye Municipality, have embraced sweetpotato silage production as a key activity. The groups adopted sweetpotato silage for income generation and to encourage other youth to engage in agriculture. Members of the groups have demonstrated the process to farmers and at schools and agricultural shows. With the help of motorized vine choppers provided by the project, they are able to offer a silage-making services to farmers. Over the past four years, the groups have marketed over 600 metric tons of high-quality sweetpotato vine silage to livestock farmers.

My major role in this assignment were:

1. Visited/monitored sweetpotato silage marketing hubs at Namulonge and Luwero districts to ensure that quality sweetpotato silage is produced and stored properly.
2. Supported the youth groups to market the silage they produced. This was achieved through using media (newspapers articles) and WhatsApp livestock forums.

3. Trained (practical and theory) youth groups and individual farmers on sweetpotato vines silage production and utilization as a high-quality feed for pigs, cattle, rabbits and goats and as a source of income.

Details of activities are indicated in the report and annexes 1, 2, 3 and 4.

Deliverable 1: Capacity building and product delivery activities aimed at strengthening the silage hubs

1.1. Capacity building

During the period of 1st August to 27Th September 2021, I trained 140 farmers (56 youth, 19 men and 65 women) at Kyakuwa Farm, Makindye Ssabagabo Municipal Council, Wakiso district (records are available in our visitor's book). Some (33) of the farmers were (a) urban dairy cattle and pig farmers from Buziga and Makindye who were interested in learning about sweetpotato vine silage technology and (b) youth who want to start sweetpotato silage production as a business/service delivery. The youth were from different parts of Kampala and Wakiso districts. The participants observed the Ministry of Health COVID-19 Standard Operating Procedures (SOPs) preventive measures. Major outputs from the training were:

(a) Capacity of youth, women and men to produce high quality sweetpotato vine silage was enhanced.
(b) Fifteen (15) youth from Mpigi (5) and Kampala (10) districts requested for a training on sweetpotato vine silage.


Some of the farmers and youth who visited Kyakuwa Farm

1.2. Product delivery activities aimed at strengthening the silage hubs

1.2.1. Handover of motorized forage choppers to youth groups

On 6th September 2021, CIP handed over two motorized forage choppers to (Bavubuka Twekembe, Luwero/Wakiso districts and Namulonge-Kasambya Sweetpotato Growers' Group, Busukuma Sub-County, Wakiso District. The groups were represented by their Chairperson and Vice Chairperson, respectively. The function was attended by Mr. Norman Kwikiriza on behalf of Dr. Frederick Grant, Country |Manager, CIP; Hajati Sarah Mayanja, Senior Research Associate, Gender and Food Systems, CIP and Mr. Joshua Kato, Editor, Harvest Money, New Vision paper (Vision Group). My major roles in this activity were:

(a) Ensuring that the forage choppers were in good working condition and safe for the users before they were delivered.
(b) Mobilizing the youth groups to attend the handover.
(c) Liaise with the journalist to document the activity.


Mr. Norman Kwikiriza, CIP and Hajati Sarah Mayanja, CIP handing over forage choppers (documents) to Mr. Lutwama, Chairperson, Bavubuka Twekembe Group (left) and Ms. Olivia Nakawesa, Vice Chairperson, Namulonge Sweetpotato Growers' Groups (right), respectively

Namulonge group testing the machine on 27th September 2021 at the marketing hub

1.2.2. Production of sweetpotato vine silage

(1) Bavubuka Twekembe Group

The group produced and sold 1.5 tons of silage. Currently, there is a shortage of sweetpotato vines because the planting season has just started. I linked the youth group to the sweetpotato programme at NaCRRI to supply sweetpotato planting varieties such as NASPOT 11 that produce high fodder yield throughout the year. The group has also identified "Wagabolige" a perennial variety that produces high fodder yield.

Sweetpotato vines silage production in Luwero district

(2) Namulonge Sweetpotato Growers' Group

The group has not been producing silage because the forage chopper they had been using belonged to the National Livestock Resources Research Institute (NaLIRRI). Unfortunately, the institute removed the chopper for research purposes. The group sold 1.3 tons of silage at Shs 600 per kg. during the month of August 2021. The members continued to maintain/weed the sweetpotato field they established at the National Crops Resources Research Institute (NaCRRI), Namulonge. NaCRRI allowed the group to use 1 acre of the institute's land to plant

sweetpotato for food (roots) and feed (vines silage) production. The group plans to harvest the sweetpotato roots during the month of September 2021.

(3) The Next Generation Agricultural Entrepreneurs, Makindye sub-county, Wakiso district:

On 30th August and 7th September 2021, five members of the group were contracted to make silage for three farmers in Wakiso district. The group produced 5 tons of sweetpotato vine silage for the farmers. The group was able to earn Ushs 250,000 which they used to buy feeds for their chicken. The group has also been able to get 5 more farmers who requested for their services. The members have plans to expand the activities in other areas within Kampala and Wakiso districts.

I have connected the group to sweetpotato growers within and outside Bunnamwaya village and to Mr. Enock Karangwa (Tel: 0777348087), a youth vendor in Owino market, Kampala district to supply the vines to the group.


Mixing banana peels, sweetpotato vines and maize bran


Members of The Next Generation Agricultural Entrepreneurs making sweetpotato vines silage at Kyakuwa Farm

The Next Generation Agricultural Entrepreneurs group members also demonstrated the sweetpotato vine silage technology to farmers from Buziga and Makindye, Kampala.

(4) MADCO Investment Limited

Mrs. Martha Matovu is the Director, MADCO Investment Limited located in Bombo, Luwero district. Martha has made sweetpotato vine silage the foundation of a new family-run business. Matovu is a qualified mechanical engineer who used to work for Brazafric, a company that imports and sells motorized forage choppers. Her experience at Brazafric convinced her that sweetpotato vine silage could be profitable. Primarily, she says that it is a source of employment. "We have given young people opportunities to work all along the value chain: from planting to sweetpotato vine silage making, packaging and delivery. This has generated income for everyone involved." The profit, Matovu explained, depends on the source of the vines. If the vines are essentially free, from one's own plot, for example, or very nearby so that transport costs are minimal, then the profits are larger. But even if one has to buy the vines, it is possible to make a profit on selling the silage. There is also a networking effect, with satisfied customers leading to increased business. "As we disseminate this new technology," she said, "we have got more clients."

So far, Matovu has bought nine motorized choppers and made silage from about 12 hectares of vines. Her main challenge now, apart from farmers whose fields are inaccessible, is finding labour to process the silage.

I have supported Martha through training to ensure that she produced quality silage. I connected her to new (16) farmers who wanted to make silage but lacked forage choppers. The farmers included high ranking policy makers.

1.3. Urban Dairy Cattle and Pig Feed Innovations Based on Market and Industrial Wastes: Examples from Kyakuwa Farm, Wakiso District

1.3.1. Introduction

Due to the increase in human population in Uganda and most of it moving to urban cities, there is increased demand for food, and this has resulted in the production of large amounts of agricultural wastes, both at farmer, municipality and city levels. The bulk of the agricultural food in Uganda is transported to cities such as Kampala in its raw form, thus compounding the net effect on large deposits of waste in urban markets, around homes and in slums as well as in various dumping grounds. Research conducted at Kampala City Council Authority (KCCA) showed that in the city of Kampala, Uganda, over 1,500 tonnes of garbage are generated daily that KCCA is overwhelmed by the waste output due to its lack of capacity to collect and dump it at its landfills in Kitezi, Wakiso district. Over 70 percent of the garbage collected are banana peels and sweetpotato vines. Three quarters of garbage rots uncollected on pavements, streets, sewerage outlets and water channels. This unfortunate tragedy is witnessed especially in markets, blurring the city's image and posing a serious health danger.

Most of these agricultural wastes such as banana peels have high nutrient levels of Nitrogen, Potassium, and Phosphorus. Such wastes can be processed and converted into high quality dairy cattle feeds. This alternate method of utilisation of agricultural and industrial wastes by dairy cattle farmers can reduce the rate of accumulation, with subsequent reduction on environmental pollution thus improving environmental health and dairy cattle productivity and household income.

(a) Banana peels

Banana peel constitutes about 38% of the total weight of the banana fruit. In addition to the use of banana peel as a potential low-cost feedstuff for dairy cattle, one of the most important aspects of its use is associated with the reduction of the environmental impact caused by the disposal of this residue in nature, since the small agro-industries in Uganda do not have the resources for treatment and proper disposal, and the peels are s often discarded in the food markets.

Sacks of banana peels at USAFI market in Katwe, Kampala

Fresh banana peels

Banana peels are a rich source of carbohydrates, mainly pectin (10 to 21%), as well as high soluble carbohydrate content, (32.4% dry matter), depending on the cultivar. Banana peels contain 6-9% protein in the dry matter and variable quantities of starch and soluble sugars, depending on their stage of maturity. Green plantain peels contain 40% starch that is transformed into sugars after ripening.

A lactating dairy cow needs a good supply of glucose due to the demands of milk synthesis for glucose. It is practical to produce animal ensiled feedstuff by utilizing banana peels which have been discarded in urban food markets which will advantage the small-scale urban dairy cattle farmers.

Despite the potential use of banana peels in dairy cattle feed, handling this by-product has complicated its use by farmers because of the high moisture content (about 80%). Therefore, it is necessary to support? the processing of this material to reduce the moisture content, allowing nutrient concentration and inhibition of the proliferation of deteriorating microorganisms, longer storage time and reduction of transportation costs.

Silage is one of the preservation methods for animal feed during periods of feed shortages through fermentation. It has a potential to be an alternative livestock feed resources for dairy cattle. Ensiling banana peels with other feeds such as sweetpotato vines and/or maize stover has an appreciable level of nutrient and can be adopted in dairy cattle or pig feeding in urban and peri-urban areas.

For small-scale urban and peri-urban dairy cattle farmers, the high-grade conventional feed resources such as Napier grass is quite expensive to get and also less available. In spite of this problem, it is necessary to increase the availability of alternative feed resources for cattle. Therefore, producing feed resources from ensiled banana peels that contain valuable nutrients like glucose is important as alternative feed resources, especially for resolving scarcity of feed resources.

(b) Maize residues

Maize residues consist of stalks, leaves, and husks of maize plants left in the field following the harvest or in food markets after selling fresh or roasted maize cobs. Two market vendors in USAFI market in Katwe collect fresh maize residues (leaves and stems) from women and men who sell fresh maize cobs, sun dry the leaves and stems and sell the stover at Shs 1,500 per 50 kg sack.

Farmers in urban areas overlook this economical source of feed for their dairy cows. Still, those who attempt to use it fail to extract maximum energy from maize stover. Yet this is a strategy that can be adapted to lower the cost of feeding without necessarily lowering the physical growth process and productivity. Maize stover is a highly fibrous feed of limited digestibility and palatability that requires treatment to enhance its nutritional value. The feeding value of maize stover can be improved by ensiling it with banana peels and sweetpotato vines. Maize stover is one of the main roughages available during the dry season.

Women selling fresh maize cobs in USAFI market

Maize residues being sundried in the market compound

Maize stover at USAFI market, Katwe, Kampala city

(c) Brewer's spent yeast solution

Brewer's spent yeast solution is a prevalent by-product of the brewing industry, created when the yeast used in fermentations is no longer useful and must be disposed of. The spent yeast cells are removed at the end of the bulk fermentation.

Brewer's Spent Yeast at Kyakuwa Farm, Wakiso District

A small amount of brewer's spent yeast solution is used to start the next batch of fermentation; however, the majority of the spent yeast solutions discarded. This discarded yeast is high in nutrients, in particular proteins (45–60% protein), vitamins and minerals, and is generally regarded as safe. Brewer's spent yeast solution can be obtained from Uganda Breweries, Luzira and Nile Breweries in Jinja district. It is free of charge.

At present, farmers use brewer's spent yeast is mainly during the production of maize stover haylage as a cheap and readily available source of protein. **Haylage** is made by ensiling chopped dry forage mixed with diluted molasses mixed with brewer's spent yeast solution in a silo under airtight condition.

Dairy productions systems have seen major changes over the past decade. The number of urban small scale dairy cattle farms with increasing specialization of milk production is growing strongly. Major challenges of urban dairy farms is the unavailability of land to grow fodder, a reason for which the cow's diet is based on purchased feed. Most of these agricultural and industrial wastes have high nutrient levels of Nitrogen, Potassium, and Phosphorus. Such wastes can be processed and converted into high quality dairy feeds to improve dairy cattle production in urban areas. This alternate method of utilisation of agricultural and industrial wastes by dairy cattle farmers can reduce the rate of accumulation, with subsequent reduction on environmental pollution thus improving environmental health and dairy cattle productivity and household income.

(d) Molasses

Molasses is a by-product from a sugarcane factory. It is the heavy, dark viscous liquid remaining after the final stage of sugar crystallization. Generally, molasses is in dry or liquid form and is a source of dietary sugars for dairy cows. Molasses is used as a pasture supplement and as a blend for unpalatable but beneficial dry feeds such as maize stover. Feeding molasses to a dairy cow helps the rumen function and ultimately the digestibility of

other feeds the cow is eating. Molasses provide energy for dairy cows and contribute to improving milk yield.

Molasses

Cows with ketosis (a metabolic disorder that occurs in cattle when energy demands e.g., high milk production exceed energy intake and result in a negative energy balance.) have poor appetite.

In order to improve the quality of sweetpotato vine silage, Kyakuwa Farm together with The Next Generation Agricultural Entrepreneurs group have introduced two new innovations/products based on sweetpotato vines, banana peels, maize stover and/or brewer's spent yeast.

1.3.1.1. Innovation 1: Ensiling wilted banana peels with sweetpotato vines (for improved pig and dairy cattle performance)

Methodology

1. Wilt clean (without foreign materials) banana peels under sunshine for about 2 hours to reduce moisture content. Clean banana peels are available at USAFI market in Katwe, Kampala city. A sack of about 60 kgs of banana peels costs Shs 4,000.

2. Chop the sweet potato vines into small pieces of about 3 cm length using a forage chopper. The finer the chopping, the better the compaction and therefore the more successful the storage, due to the effective exclusion of air. Chopping into small pieces can be done by hand or with a forage chopper. Sweet potato vines are available in Owino market. They are delivered at Kyakuwa Farm at Shs 50,000 per pick-up (big Toyota Townace) (produces about 350 kgs of sweet potato vine silage). This includes cost of transport, labour and the vines.

3. Wilt sweet potato vines under sunshine for about 3 hours to reduce moisture content. Wilting produces stable silages and the higher the stability, the higher the quality.

4. Mix wilted banana peels (1) with wilted chopped sweet potato vines (3) in a ratio of 1 bag (about 60 kgs) of banana peels and 2 bags (about 140 kgs) of sweet potato vines.

5. Add 10 kgs of maize bran for every 100 kgs of a mixture of banana peels and sweet potato vines and mix thoroughly. Maize bran increases the production of lactic acid which serves as a preservative.

6. Ensile the material (5) in an airtight or polythene tube silo and store for 30 days in a well-ventilated store.

7. The silage can be mixed with grass hay to improve the quality of grass hay.

8. Supplement milking cows with a source of energy and minerals and provide plenty of clean water.

1.3.1.2. Innovation 2: Ensiling banana peel bran and maize bran with sweetpotato vines (for improved pig and dairy cattle performance)

Methodology

1. Wilt clean (without polythene material) banana peels.

2. Chop maize stover into pieces of about 3 cm length using a forage chopper. Maize stover (leaves and stems) can be bought from farmers' fields or from Owino and USAFI markets.

3. Chop sweet potato vines into pieces of about 3 cm length and wilt them under sunshine for about 3 hours.

4. Mix banana peels (1) with maize stover (2) and sweet potato vines (3) in a ratio of 1 bag (about 50 kgs) of banana peels, 3 bags (about 210 kgs) of maize stover and 2 bags (about 140 kgs) of sweet potato vines (3).

5. Mix molasses (heavy, dark viscous liquid) with brewer's spent yeast in a ratio of 1 jerrican molasses with 3 jerricans of brewer's spent yeast (you can mix molasses with water using the same ratio). Some of the molasses sold to farmers is a bit diluted. This means that you will use more molasses to produce quality silage.

6. Spread the solution (5) over a mixture of maize stover, banana peels and sweet potato vines and mix thoroughly until the material is completely wet. Molasses provide the animals with sugar (energy) while brewer's spent yeast provides protein, minerals and vitamins. Molasses improves palatability of the feed and aid fermentation during silage making.

7. Store the mixture (6) in airtight plastic drums or polythene tube silos (for urban farmers) for 30 days.

8. Supplement milking cows with a source of energy and minerals and provide plenty of clean water. The feed enhances milk and beef production.

We recommend research to be conducted to verify the effects innovations on dairy cattle or/and pig performance.

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