ILRI MANUAL 16

RESEARCH PROGRAM ON Livestock and Fish

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Pig feeding strategies

Uganda smallholder pig value chain capacity development training manual


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Pig feeding strategies

Uganda smallholder pig value chain capacity development training manual

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Contents

Acknowledgements 1

Abbreviations 2

Introduction 3

Expected outcomes 5

Glossary of technical terms used in this module 6

Training methods 7

Proposed training schedule 8

Tools and materials (prepare in advance) 9

Training aids/handouts 10

Background 11

Session 1Nutrient requirements of pigs 12

Background 12

Session 2 Feed resources 17

Background 17

Session 3 Crop residues 25

Background 25

Session 4 Strategic supplementation 40

Background 40

Session 5 Water use in pig production 43

Background 43

Module summary 45

References 46

Tables

Table 1.	Nutrient requirements of different categories of pigs	13
Table 2.	Requirements of protein and selected amino acids in pigs of different weights and physiological stages	13
Table 3.	Estimated daily consumption of feeds by different categories of pigs	14
Table 4.	Maximum levels of inclusion for ingredients commonly used in pig diets	21
Table 5.	Summary of the nutritive value of protein supplements	22
Table 6.	The nutritive value of energy supplements	22
Table 7.	Summary of constraints associated with the use of some feed resources	23
Table 8.	A model of how to report the results of the exercise	24
Table 9.	Most available crop residues in your area/region	25
Table 10.	Rations for growing and fattening pigs including sweetpotato vines	26
Table 11.	Rations for pregnant and lactating sows that include sweetpotato leaves	27
Table 12.	Sweetpotato leaf yields	27
Table 13.	Nutrient composition of sweetpotato vines on dry matter basis	28
Table 14.	Nutrient composition of tubers and leaves in two species of yams (%DM)	33
Table 15:	Performance of growing pigs fed on yam	33
Table 16.	Anti-nutritional factors in yams, their effects and mode of elimination	33
Table 17.	Silage preparation formulas	37
Table 18.	Amount of silage to be offered to pigs, as a function of body weight	38
Table 19.	Pig water requirement at different growth stages	44

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Abbreviations

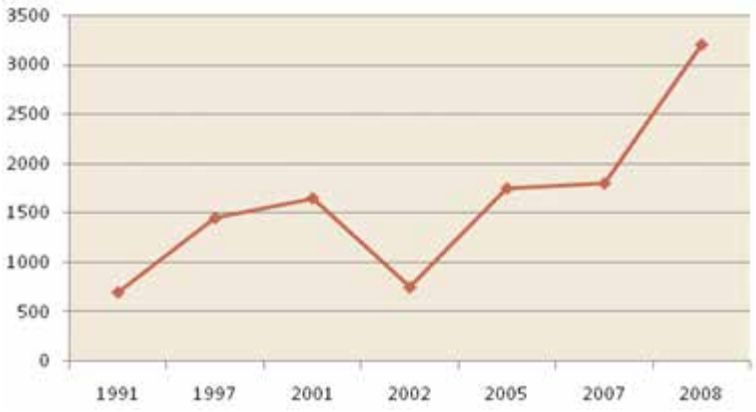
BRAC	Bangladesh-based development organisation formerly known as the Bangladesh Rehabilitation Assistance Committee
CRP	CGIAR Research Programme
DVO	District Veterinary Officer
EC	European Commission
FAO	Food and Agriculture Organization of the United Nations
IFAD	International Fund for Agricultural Development
ILRI	International Livestock Research Institute
MAAIF	Ministry of Agriculture Animal Industry and Fisheries
NAADS	National Agriculture Advisory Service
NaLiRRI	National Livestock Resources Research Institute
NGO	Non-Governmental Organization
UBOS	Ugandan Bureau of Statistics
UN	United Nations
VEDCO	Volunteer Efforts for Development Concern

Introduction

Pork production and consumption have risen rapidly in Uganda over the past decade, driven by population growth, urbanization, increasing incomes and changing tastes. In 2011, Uganda had the highest per capita consumption of pork in East Africa (3.4 kg/person per year).

The number of pigs has increased more than tenfold from less than 200,000 three decades ago to roughly 3.2 million. More than 1 million households in Uganda raise pigs. The majority of the pigs are kept by women in rural areas, with limited access to technology, services and markets.[1]

Figure 1. Trends (000) in the number of pigs in Uganda, 1991–2008.



Source: National Livestock Census Report (2008).

The CGIAR Research Program on Livestock and Fish,[2] led by the International Livestock Research Institute, started the Smallholder Pig Value Chain Development Project to improve the livelihoods of smallholder pig producers, particularly women, through increased productivity, reduced risk from disease, and improved market access.

A key activity of the project is to strengthen the capacity of women and men pig producers, and help them transform subsistence-level pig-keeping into viable, profitable businesses. A companion project, 'Safe Food, Fair Food', under the CGIAR Research Program on Agriculture for Nutrition and Health,[3] is working to improve pork safety and market access. These efforts, in turn, should enhance food security, help preserve natural resources and reduce poverty. Poverty in Uganda currently stands at 37.8% (people living on less than USD 1.25 per day).

These training modules are targeted to extension workers, veterinarians and para-veterinarians, and policymakers responsible for animal production, and for livestock market development and regulation. Improved knowledge should help provide incentive for decision-makers to help poor pig farmers, and promote the sector.

1. Find ILRI pig value chain assessment slide share presentations here: http://slidesha.re/1IojJPX
2. CGIAR Research Program on Livestock and Fish, http://livestockfish.cgiar.org/
3. Learn more about the program here: http://www.ilri.org/crp[4]

Others who may benefit from the training modular content include suppliers, pig producer organizations, transporters and entrepreneurs involved in the sale of live animals, pork and other pork products.

ILRI has also developed training modules on pig management, control of African swine fever, parasite control, selection and management of village boars, business management, and marketing to help strengthen the capacity of farmers.

While designing the modules a process has been facilitated with research and development partners to practice the delivery of the packages.[4]

4. Learn more here: http://www.slideshare.net/ILRI/capacity-development-in-the-uganda-smallholder-pig-value-chain-development

Expected outcomes

This module is designed to train farmers, extension staff and others who advise smallholder pig farmers on the nutritious value of local feed and the strategic use of supplements to enhance animal performance and farmer income. Feed dealers/distributers also can benefit from this module, which covers single feed ingredients, additives, and mixed/ compound feed that can be used to supplement diets based on crop residues, forages and kitchen leftovers.

Upon successful completion of the module, participants should be able to:

- Identify the limitations of local feed resources.
- Describe pig nutrient requirements at different stages or physiological states.
- Mix different feeds to meet the nutrient requirements of pigs.
- Implement strategic supplementation to enhance pig performance.
- Make better use of water.

Glossary of technical terms used in this module

Balanced diet:	Feed with all the required nutrients in the right proportion.
Basal diet:	A diet for maintaining the fundamental activities of an animal.
Conservation:	Process of preserving feed.
Crude fibre:	Portion of feed in the diet that is not easily digested and available for animal use.
Crude protein:	Estimate of the protein fraction in the feed that is calculated by measuring the amount of nitrogen in the feed and multiplying the figure by a factor of 6.25.
Cultivar:	Plant variety produced by selective breeding.
Dry matter:	True, moisture-free nutrient content of a food.
Energy:	Capacity to do work. Is also considered a nutrient, and the energetic value of any feed is estimated using a calorimeter.
Ensile:	Putting grass or other fodder into an airtight container to preserve it as silage.
Fermentation:	Process of conserving fresh fodder in the absence of air with assistance from anaerobic microbes.
Flushing:	Feeding program that increases the ration received by a gilt prior to breeding.
Forage:	Growing plants that animals can eat.
Mcal:	Megacalories, is an expression of the energy content of a feed, and is equivalent to one million calories.
Metabolizable energy:	An expression of the energetic value of a feed. It considers the proportion of energy that is digested by the animal, and the amount that is lost in the urine and gases.
Nutrients:	Feed constituents that are required by animal bodies for specific function
Palatability:	Willingness of pigs to eat a particular feed.
Panga:	Word commonly used in Uganda to refer to a machete
Silage:	Grass or other green fodder compacted and stored in airtight conditions, typically in a silo, and used as animal feed in the winter.
Trace minerals:	Minerals required in very small amounts to meet nutrient requirements.

Training methods

Familiarization with the concepts, knowledge, skills and the attitudes of the subject matter by the trainer is a prerequisite for effective delivery. Therefore this module provides basic information for the facilitator to prepare learning sessions. In addition, trainers are advised to use adult learning principles, for example sharing experiences. The training sessions should be simple, realistic and practical. The use of participatory approaches that promotes 'learning by doing' is always recommended.

Depending on where the training takes place, related tools and materials can be used. For example if the training is on a pig farm, the trainer can make use of live animals and farm resources for a real life experience. If the training is in a classroom setting, the facilitator could make use of books, drawings, photos and even virtual resources if there is connectivity to the Internet.

The smallholder farmer participants have practical knowledge on rearing pigs, including feeding, so the trainer should try to find out what participants know and don't know, and enhance that knowledge. In many cases, farmers aren't clear about the specifics of feed nutrients and its relevance to productivity; therefore the use of examples, case studies and sharing of experiences— even from other livestock species—can help participants understand the concepts.

The methods of delivery will be a combination of short lectures on the subject matter, focused group discussion, brainstorming, practical exercises, analysis of case studies, demonstrations, and the use of illustrations, feed samples or live animals. For each session of the module, appropriate delivery methods should be used to improve knowledge, develop skills and create changes in farmer attitudes.

Proposed training schedule

Session 1: Nutrient requirements of pigs (time/duration: 2 hours)

- The digestive system of the pig
- Nutrient requirements of different categories of pigs
- Protein and selected amino acid requirements of pigs

Session 2: Feed resources used in pig production (time/duration: 9 hours, in different sessions)

- Feeds used as supplements

Session 3: Crop residues (time/duration: 4 hours)

- Plant residues
- Animal residues
- Silage making

Session 4: Strategic feed supplementation (time/duration: 3 hours)

- Use of amino acids
- Use of enzymes
- Use of fruits
- Use of whey (spent milk)
- Use of commercial supplements

Session 5: Water use in pig production (time/duration: 1 hour)

- Water requirement by pigs
- Water harvesting technologies

Module Review (time/duration: 30 minutes)

Tools and materials (prepare in advance)

- Ringer binder with outline of the training programme
- Training handouts (see below)
- Notebooks and pens
- Masking tape
- Flip charts, markers
- Computer, LCD projector for PowerPoint presentations if electricity is available
- Camera
- Pig nutrient requirement tables
- Photographs of pig and cow digestive systems
- Samples of different feed resources or marked cards to represent samples.
- Puzzles for dividing participants into the required groups for activities one and two.
- Feed samples
- Sweetpotato vines/cassava leaves
- Maize bran (not needed if tubers are ensiled)
- Salt
- Panga
- Sisal string
- Plastic bag. Plastic sheaths if the silage is made in a silo pith
- Forage chopper/slicer
- Black polythene sheet to line a pit
- Hoe
- Gutter for collecting water
- Plastic pipe to connect water from the roof top to the storage pit

Training aids/handouts

- Pig nutrient requirement tables
- Feed composition tables
- Photographs of pig and cow digestive systems.

Background

The seasonal variation in the availability and quality of feed makes it one of the major constraints in smallholder pig production. Irrespective of the pig system practised, feed accounts for 60–80% of the total cost of production. Farmers frequently use crop residues, green fodders and kitchen leftovers to reduce feeding costs, and in many cases supplement those with commercial or home mixed concentrates. While crop residues and foraged food are frequently good sources of vitamins, they have high levels of fibre, which can be difficult for pigs to digest.

A study in three districts of Uganda indicated that farmers often lack information regarding the nutritional content of the local feed resources and the nutrients required by their pigs at different ages and physiological stages, such as lactation, weaning, and pregnancy. This module also emphasizes the importance of water in pig production, and proposes some cost effective water harvesting technologies.[5]

5. For more information about pig feeding, forages and water requirements:
http://www.slideshare.net/ILRI/opportunities-for-feeding-forages-to-pigs-in-uganda
https://fodderadoption.wordpress.com/2014/09/18/the-feeding-component-in-rural-and-peri-urban-smallholder-pig-systems-in-uganda/
http://www.slideshare.net/ILRI/spvcd-uganda-feedbreed
http://www.tropentag.de/abstracts/posters/693.pdf

Session 1 Nutrient requirements of pigs

Objective: Describe the nutrient requirements of pigs at different stages

Tools and materials:

- Pig nutrient requirement tables.
- Photographs of pig and cow digestive systems.
- Samples of different feed resources or marked cards to represent samples.
- Puzzles for dividing participants into the required groups for activities one and two.

Time/duration: 2 hours

Instructions: It is recommended that an extension officer, animal production technician or veterinarian leads the session.

Background

The appearance and performance (growth rate, fertility, milk production) of pigs depend on their genetic potential and the conditions under which animals are managed. Therefore any manipulation of the environment, including feeding strategies, will influence animal performance. There is a large variation in the feeding strategies employed by farmers, and a variety of feedstuffs are provided to pigs. In most cases, farmers are not aware if the feeds used are able to meet the nutrient requirements of their pigs. To benefit from pig rearing, pigs should be fed on diets that supply the required nutrients for better health and performance. The nutrient requirements of pigs, as in other livestock species, are a function of age, weight and physiological status.

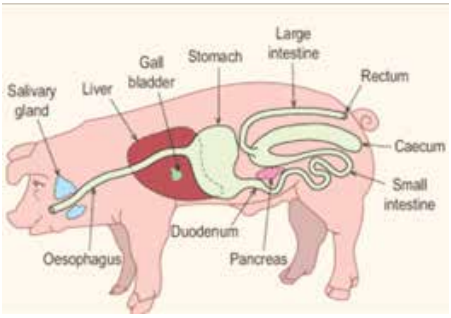
Digestive system of the pig

The type of digestive system determines the feed best utilized by a given kind of livestock. The pig is characterized as a simple stomached animal because it has only one chamber, while cattle, goats and sheep have four chambers.

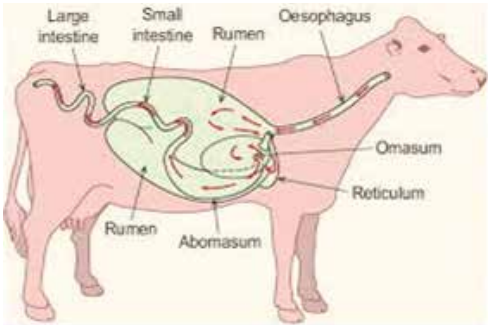
In all species, digestive juices including enzymes break down complex nutrients into simple amino acids and sugars that can be absorbed into the blood stream.

A cow is in better position than a pig to digest fibre because it has a rumen, in which microorganisms break down the fibre through fermentation—the fermented material (cud) then can be sent back to the mouth for further chewing, and some of the gases can be absorbed through the rumen wall to provide energy to the animal. Also processed feed passes to the stomach and intestine for the action of enzymes. Fermentation also occurs in the pig, but in the large intestine, which is small in size compared to the rumen in animals of the same size. Therefore, pigs are not well adapted to digest fibrous feed.

Digestive system of a pig



Digestive system of a cow



Nutrient requirements of different categories of pigs

The optimum performance of pigs is achieved by providing adequate nutrients. Proteins are body building foods required by pigs; however, excess protein is used as an energy source, while too little protein in the diet results in stunted growth, and eventually in higher deposition of fat in the carcass, a problem frequently faced by many pig farmers when slaughter their pigs. Calcium and phosphorus are minerals important for bone and teeth formation and strength; inadequate levels lead to weak bones and the possibility of recurrent fractures. There are other minerals required in small amounts, called 'micro-minerals' or 'trace elements', with specific action in the metabolism (use of other nutrients). Pigs require energy for maintenance, physical activity, growth, reproduction and lactation among other things. Vitamins not only defend pigs against some diseases, but help pigs to utilize other feeds. Water is essential for normal body functioning.

Protein and selected amino acid requirements of pigs

The amount of nutrients required by pigs varies with age and weight. Table 1 below shows the requirements of digestible protein, digestible energy, calcium and phosphorus of pigs at different ages, and mature pigs of different physiological stages. Lactating sows for example require better diets than gestating sows. Table 2 shows the variation on the requirements of relevant essential amino acids for different categories of pigs.

Table 1. Nutrient requirements of different categories of pigs

Weight of pigs (kg)	Digestible protein (%)	Digestible energy (Kcal/day)	Calcium (%)	Phosphorus (g/kg)
0–3	17.0	3400	0.9–1.0	0.75
3–6	16.0	3350	0.8–1.0	0.75
6–10	16.0	3300	0.8–1.0	0.65
10–16	14.0	3300	0.7–0.85	0.60
16-Slaughter	13.0	3300	0.6–0.75	0.50
Lactating sow	13.0	3200	0.9–1.10	0.60
Gestating sow	11.0	3050	0.60–0.70	0.55

Credit: NRC nutrient requirements of swine, 9th revised edition.

Table 2. Requirements of protein and selected amino acids in pigs of different weights and physiological stages

	Growing pigs				Sows	
Body weight/kg	11 to 23	23 to 34	34 to 57	57 to 102	Gestation	Lactating
Crude protein(g/kg)	180	160	140	130	120	130
Lysine (g/kg)	7.9	7.0	6.1	5.7	4.3	5.8
Methionine + Cystine (g/kg)	5.1	4.5	4.0	3.0	2.3	3.6
Tryptophan (g/kg)	1.3	1.2	1.1	1.0	0.9	1.2

Credit: NRC nutrient requirements of swine, 9th revised edition.

In many cases amino acid supplements are sold in 'sachets" with recommended dosages. This makes them simple to use.

Table 3 gives estimates of the amounts of feeds that pigs of different categories/ages can consume daily. This data should be considered as a reference, because applies to dry feeds, and many cases forages and crop residues could have important contents of water (more than 60%), then the amount eaten could be greater than the values presented in the table.

Table 3. Estimated daily consumption of feeds by different categories of pigs

Categories	Age	Feed
Weaner pigs	2–4 months	0.25–0.75kg/day
Grower pigs	5–6 months	0.75–1.50 kg/day
Adults	7–10 months and above	1.50–2.50 kg/day
Sow	Pregnant/Lactating	2.50–3.50 kg/day

Suckling sow.

Credit: Geoffrey Beyihayo.

Weaned pigs.

Credit: Geoffrey Beyihayo.

Lactating sows, suckling piglets and weaned piglets have different nutrient requirements.

Exercise 1 Learning about nutrients (time/duration: 30 minutes)

- Divide the participants into three groups. Group 1 will work on the diet of breast feeding mothers, Group 2 will work on the diet of youth and Group 3 will work on the diet of children younger than 2 years old.
- Ask participants to list the foods preferred by the category of people they have been assigned.
- List them on a flip chart /blackboard.
- Classify/group the lists depending on the major nutrients they supply.
- Compare the foods recommended for the three groups, discuss and make some analogies/comparisons to pigs.

Use the templates below to summarize the findings by the different groups

Group 1Breast feeding mothers

Food	Major nutrients/class

Group 2 Youth

Food	Major nutrients/class

Group 3 Children (less than 2 years old)

Food	Major nutrients/class

Exercise 2 Classifying pig feeds in terms of the main nutrients those provide (time/ duration: 30 minutes)

- Request the participants to split into three groups. Group 1 will work on lactating sows, Group 2 on piglets, and Group 3 on growers or gilts.
- Ask each group to discuss the feeds commonly offered to the respective category of pigs.
- List the results on a flip chart /blackboard.

Classify/group the feed depending on the major nutrients the feed supplies

Use the format below to summarize findings by different groups:

Category of pigs	Feed/ingredients (e.g. sweetpotato vines)	Major nutrient/Class (e.g. carbohydrates)	Limiting nutrient(s) (e.g. protein)
Lactating sows			
Piglets			
Growers or gilts			

Note: The table can be expanded according to the feeds identified by each group

Guiding questions:

- What is missing in the feeds/ingredients listed in the table for each category of animals?
- What should be added? (basis for strategic supplementation)

Note: Address the questions to the entire group, so all participants can benefit from the exercise.

Summary (time/duration: 15 minutes)

Participants under the guidance of a lead participant (chosen among them) reflect on the nutrient requirements of different pig categories and discuss any questions regarding the session.

Session 2 Feed resources

Objective: Strengthen the capacity of participants to identify and describe locally available feed resources, and the constraints.

Time/duration: 3 hours

Instructions: It is recommended to ask an extension officer, animal production technician or veterinarian to deliver this session.

Background

Although feed resources can provide multiple nutrients, they can be classified as energy, protein, vitamin or mineral sources, depending on the major nutrient they provide. Water is also an important nutrient. Knowledge on the nutrient content of different feeds is critical to assure meeting the nutritional requirements of target animals.

Protein/body building feeds (time/duration: 1 hour)

Proteins are body building foods essential for growth and normal functioning. Insufficient levels will result in stunted growth, low milk production in sows and poor reproductive performance. Proteins can be of plant or animal origin. The latter is more expensive because of its high nutritive value and consequently is used in relatively small amounts compared with plant protein. Plant protein sources are dominated by the oil by-products of such crops as cotton, sunflower, soybean, oil palm and ground nuts. Oil is extracted using mechanical (pressing) or chemical (solvent) methods. These by-products are called ‘cakes’. Meals also can be produced by milling/grinding complete oil seeds, but at a smaller volume, because the main reason for cultivating such crops is to extract oil. Animal protein sources include fishmeal (commonly known as ‘mukene’ in Uganda, when produced from silverfish), fish by-products, blood meal and dairy by-products such as whey. Unconventional protein sources include poultry litter and earthworms.

Plant protein sources

Sunflower cake

Sunflower is cultivated mainly in northern Uganda for oil production. Sunflower cake is a residue/by-product of the extraction of oil from sunflower seeds; although is available in the market, it is mostly purchased by large scale feed manufacturers. Smallholders can buy sunflower cake in small quantities from distributers or feed stockers.

Although sunflower cake is considered a protein source, it is also an energy-rich feed. Sunflower cake contains a large proportion of methionine, an amino acid which is at low levels in most feeds, including the majority of plant protein supplements. The presence of aflatoxins (a toxic compound present in non-properly dried feeds that have developed mould) have been reported in sunflower cake available in the markets. No more than 10% sunflower cake should

be included in most rations for pigs, due to its high fibre content and its effect of depositing soft fat in the carcass; however it is acceptable to include up to 12.5% sunflower cake in rations for sows.

Sunflower meal

Sunflower meal is the product of milling sunflower seeds, and also is rich in protein and energy. Quality varies, however, due to plant characteristics, processing technique and storage conditions. Sunflower meal can be prepared from whole or dehulled (without peelings) seeds, and this influences its composition. Sunflower meal does not need any heat treatment before feeding to pigs; however its inclusion is limited by its fibre content and amino acid deficiency especially lysine; therefore sunflower meal should not represent more than 10% of the total ration. Sunflower meal can be compacted to any shape for ease of transportation.

The production process of sunflower cake or meal frequently is indicated on the package/bag to enable the buyer to have an idea of the quality of the product. If not, it is recommended to check the colour. The colour of the meal or cake varies from grey to black depending on the degree of dehulling and extraction process. Meals or cakes with fewer hulls (consequently with higher protein content) tend to appear of grey colour, whereas ones that haven't been dehulled tend to look very dark.

Cottonseed cake

Cottonseed cake is the residue after extraction of oil from cotton seeds. Cotton seeds are dehulled, cracked, dried and heated before being pressed or chemically extracted. It is also rich in protein and energy, and has moderate levels of lysine and methionine. The protein concentration varies depending on the soils, climate, varieties and efficiency of the oil extraction method. In general, the energy content increases, and the concentration of protein reduces when too much fat remains in the residue after oil extraction. Cottonseed cake should not exceed 10% of a pig's diet, given its high fibre content and presence of an anti-nutritional compound called 'gossypol'. Gossypol can be reduced by heating the cottonseed cake. However, heat-treated cottonseed cake isn't yet available in the Ugandan market. The content of gossypol in cotton seed cake shouldn't exceed 0.12%.

Soybean meal

Soybean is cultivated by farmers in Uganda for home food consumption and supplies industries that process soybean into a number of products. The products of soybean processing—mostly soybean meal from oil extraction—are available for feeding pigs as protein supplements. The Maksoy varieties, released by Makerere University, are commonly grown in Uganda as they are resistant to soybean rust. Oil extraction from soybean can be done by mechanical pressing or chemical methods. Good quality soybean meal contains a high amount of protein, energy and the amino acid lysine, but is poor in methionine. Soybean contains an anti-nutritional factor called anti-trypsin factor, which reduces protein digestion. However, this can be eliminated by toasting the whole grain before milling and extracting the oil. Sows and fatteners can have 10–30% of soybean meal in their diets as long as it is economically feasible. The production of soya milk leaves a by-product which is suitable for feeding pigs; however more research is needed on the nutritive value of this by-product.

Animal protein sources

Fish meal

Fish meal, most commonly 'mukene' in local markets from silverfish processing, is very rich in protein and minerals, and has a good balance of amino acids with adequate levels of methionine and lysine. It also is highly digestible. Fishmeal is an expensive source of protein, and prices are increasing due to a combination of high demand for human consumption and a declining fish catch, particularly in the lakes of Uganda.

The protein content of fishmeal is influenced by the type of fish, the fish parts processed and the level of contamination. Adulteration, poor handling and processing also affect the protein content of fish meal. Untrustworthy feed stockers/dealers add one or more non-feed materials such as sand to increase the volume of their sales. Dogs, cats, rodents and birds may be a source of contamination during drying and storage. If not properly dried, fishmeal may turn mouldy or rancid due to the high moisture content. To ensure quality, it is recommended that farmers buy dry fish, and sort or sieve to remove contaminants before milling or feeding to pigs. The inclusion of 3% and 5–10% fish meal are recommended for sows and piglets rations, respectively.

To ensure quality, a farmer in Masaka town buys, dries, sorts and sieves fish before milling. He installed a diesel engine powered grinding machine on his farm to mill fish. He said a bag weighing up to 100 kg of fish may contain up to 30 kg of sand and other contaminants, consequently the protein content of fish meal commercially available in the market is much lower than expectations.

Blood meal

Blood is collected after slaughtering animals, especially cattle, and dried into a meal. Fresh blood is highly perishable and needs to be processed as soon as possible. Blood meal is easy to handle and incorporate into rations along with other ingredients. It contains iron, calcium and phosphorus. Given its high protein content (as much as 95%) and lysine, blood meal is suitable for supplementing diets based on cereal grains, plant by-products and forages. It also can be used in pig diets to supplement other protein sources from plant origin (e.g. soybean meal, sunflower cake). On a small scale, farmers can boil while stirring fresh blood in large pans to a moisture content of approximately 11% and spread on clean surfaces to dry under the sun. Boiling to a temperature of 100°C for at least 15 minutes kills potential pathogens. Overcooking destroys haemoglobin, thus reducing palatability.

The risks associated with the use of blood meal are: poor balance of amino acids, potential source of pathogens if not properly dried and stored, low palatability and if used in excess, blood meal can cause cannibalism in pigs. Therefore it is recommended to limit it to 6–8% of compound feeds. In countries where 'mad cow disease' has occurred, the use of blood meal is banned, but that disease has not been reported in Uganda and other East African countries.

Sources of energy/carbohydrates (time/duration: 1 hour)

Cereal grains and their by-products are important sources of energy for pigs. They make up more than 50% of the ingredients in concentrates fed to livestock. Although they are used principally as energy sources, cereal grains also supply significant amounts of proteins, vitamins and minerals. In Uganda, maize bran, wheat bran, maize grain, wheat pollards and sorghum are important sources of energy for pigs. Root tubers including sweetpotato, yams and cassava are also good sources. These can be fed fresh or after drying in the sun.

Whole/broken maize

Maize is a major staple crop for a large proportion of the Ugandan population, and also can be used as feed for livestock if there is a surplus. Maize is the most common grain used for feeding pigs due to its low fibre and high energy contents, however its use in pigs has to be limited to prevent competition with human consumption. The presence of a compound called phytate reduces phosphorus utilization by animals, resulting into losses of phosphorus in the faeces. It is possible to increase phosphorus availability in maize by adding enzymes and/or processing. Pre-germination or malting is a processing technique that increases bio-availability and absorption of phosphorus from maize seeds. The process of pre-germination activates enzymes in the seeds which in turn break down phosphorus-complexes to make phosphorus more available. This reduces the excretion of phosphorus in faeces and consequently the need for phosphorus supplementation.

Maize bran or hominy feed

Maize bran is a by-product of maize flour processing, and is an important ingredient in livestock feeds in East Africa. Maize bran is composed of grain coatings, germ and grain particles. It contains less starch but more protein, fibre and

fat compared with maize grain. Excessive feeding of maize bran results in undesirable soft fat in pork, therefore its inclusion in the ration should be limited to 20–25%.

Wheat bran

Wheat bran is a by-product of the dry milling of wheat into flour. It contains the outer layer, small grain particles and small amounts of the endosperm. Wheat bran is highly palatable and suitable for feeding most farm animals. Fatteners' and piglets' diets can contain up to 30% and 10% wheat bran, respectively, given its high fibre and relatively low protein content. Sow diets should contain no more than 25% wheat bran. Wheat bran is associated with obesity in pigs when it is the only grain used in the ration, therefore, it is recommended to use wheat bran in combination with other grains.

Cassava meal

Cassava roots are harvested, peeled, sun dried and milled to animal feed grade. Cassava meal is rich in energy, with a high proportion of starch (63–72%), but is very low in protein. Diets of sows and fatteners can contain up to 40% cassava meal, while diets for piglets should contain less than 20% cassava meal. In both cases, it is necessary to use protein supplements if cassava is being used instead of maize.

Sweetpotato meal

Sweetpotato meal is prepared by washing, chopping/slicing and sun drying sweetpotato tubers, later milled to animal feed grade. Sweetpotato meal has an even higher energy content than maize bran, but is considered of inferior nutritive value because of its low protein content of only about 5%. Total replacement of cereals with sweetpotato meal is not recommended; otherwise it requires the use of higher levels of protein supplements.

Brewers spent grain

Brewers grain waste is the solid residue left after the processing of cereal grains for beer and other malt products. Barley and sorghum are the major cereals used by beer brewers in East Africa. The brewing (fermentation) process leaves a concentrated product rich in protein, some energy, and also fibre. Brewers' grains are either sold wet or dried; wet brewers' grains for later use, only if provisions are taken to prevent the development of mold. Some strategies used include the addition of common salt (1-2%) or the use of propionic acid.

Vitamins and minerals

A combination of vitamins and minerals, and eventually some amino acids (e.g. methionine and lysine) are usually packaged as a vitamin-mineral premix. The mineral and vitamin composition is always indicated on the sachet. Usually, 0.5 kg of premix is adequate for a mix of 100 kg of feed; however the user should check the labelling. In pigs of poor health or body condition, an injection of vitamins can be administered to boost appetite and recovery. Locally available resources such as bone meal, lake shells, and egg shells are a good source of calcium and phosphorus. Lake shells harvested from fresh water bodies like Lake Victoria and Albert are available in many animal feed outlets in Uganda. Egg shells can be collected in bulk from restaurants and hotels.

Precaution

- Egg shells should be heated (using charcoal) in a clay-pot over night to kill disease causing organisms, and crushed.
- Whole lake shells should be sieved to remove unwanted materials and crushed.
- Lake/egg shells are usually used in a proportion of 3–4 kg per 100 kg of feed.

An example of labelling with instructions in a vitamins/mineral premix sachet:

Fruits and vegetables are good natural sources of vitamins and minerals. These can therefore be used as supplements for pigs fed mainly on cereal-based diets. Damaged, rejected and processing by-products of fruits and vegetables are suitable for this purpose. Also, many farmers have an excess of fruit that cannot be taken to the market and can be used to feed pigs.

Maximum inclusion rates of feed ingredients in pig diets

The level of inclusion of some ingredients should be restricted due to their effects on palatability, digestibility, fibre content and/or cost. Table 4 shows recommended maximum inclusion levels for ingredients commonly used in pig diets, by pig categories.

Table 4. Maximum levels of inclusion for ingredients commonly used in pig diets

Ingredients (%)	Starter	Grower-finisher	Gestation	Lactation
Maize bran	0	60	80	60
Wheat bran	0	0	30	5
Dried brewers spent grain	0	10	40	5
Cotton seed cake	0	15	5	5
Fish meal	5	5	5	5
Sun flower cake (%)	0	10	10	5
Bone meal	5	5	10	5

When choosing inclusion rates of ingredients, the following criteria should be considered:

- Presence of toxic or anti-nutritional factors
- Influence on palatability
- Potential effect on pork quality
- Possibility of affecting the digestive system's function
- Deficiency of the nutrient

Advantages of using cereals and root meals as energy sources

- Higher nutrition value per unit of volume compared to forages.
- High storage capacity due to low moisture content.

Table 5. Summary of the nutritive value of protein supplements

Feed resource	Dry matter (%)	Crude protein (%)	Digestible energy (kcal/kg)	Crude fibre (%)	Phosphorus (%)	Calcium (%)
Sunflower meal (by dehulled, solvent)	93.0	45.5	3047	11.7	0.94	0.42
Cotton seed cake (expeller)	93.0	36.8	2980	14.3	0.71	0.20
Cottonseed cake (solvent)	92.0	41.7	2670	10.8	1.17	0.17
Soybean meal (solvent)	90.0	44.0	3490	7.3	0.65	0.3
Soybean meal (dehulled)	90.0	48.5	3680	3.4	0.64	0.26
Fish meal	92.2	61.2	3800	0.9	2.88	5.19
Blood meal (dried)	93.8	86.0	2980	1.0	0.30	0.41
Whey (fresh whey)	93.0	13.5	3215	0.2	0.76	0.86

Source: NRC, nutrient requirements of swine, 9th revised edition.

Table 6. The nutritive value of energy supplements

Feed resource	Dry Matter (%)	Crude Protein (%)	Digestible Energy (kcal/kg)	Crude Fibre (%)	Phosphorus (%)	Calcium (%)
Whole/broken maize	88.0	8.5	3530	2.4	0.29	0.03
Maize bran	90.0	10.6	3495	5.0	0.52	0.06
Wheat bran	87.0	15.5	2370	10.4	1.16	0.14
Cassava meal*	87.6	2.9	3656	3.9	0.11	0.17
Sweetpotato tuber* meal	88.0	4.6	3728	2.8	0.16	0.17
Sweetpotato tuber (fresh)*	30.0	5.5	3490	3.8	0.15	0.12
Brewers spent grain (dried)	92.0	27.5	2,090	13.1	0.51	0.3

Table 7. Summary of constraints associated with the use of some feed resources

Feed resource	Constraints	How to overcome the constraints
Cottonseed cake	High fibre content. Presence of an anti-nutritional factor called gossypol.	Heat cottonseed cake. Use varieties with low gossypol.
Sunflower cake	High fibre content. Deficient in lysine.	Dehull seeds before oil extraction. Supplement with synthetic amino acids or ingredients rich in lysine.
Soybean meal	Poor in methionine. Anti-nutritional factor called anti-trypsin.	The anti-trypsin factor is eliminated by toasting the whole grain before milling and extracting the oil. Supplement with synthetic amino acids or ingredients rich in methionine (e.g. animal protein sources).
Fish meal	Susceptible to rancidity if not properly dried.	Ensure adequate drying. Include anti-oxidants Avoid prolonged storage of feeds containing fish meal. Avoid compaction of feed during storage.
Blood meal	Potential source of pathogens. May cause cannibalism in pigs. Low palatability when used in excess.	Boil at 100 C for at least 15 minutes to kill pathogens. Use recommended inclusion rates.
Feed resource	Constraints	How to overcome the constraints
Wheat bran	Low protein content. Associated with obesity in pigs if it's the only grain used in the ration.	Supplement with protein rich ingredients. Use in combination with other grains or grain by-products.
Sweetpotato meal	Low protein content.	Supplement with synthetic amino acids or ingredients rich in protein.
Maize bran	Phytate complexes reduce phosphorus availability. Usually low in lysine and tryptophan.	Include enzymes in maize based diets. Pre-germinate/malt. Supplement with synthetic amino acids.
Cassava meal	Low protein content. Presence of a toxic compound that releases hydrocyanic acid.	Supplement with ingredients rich in protein. Sun dry tubers before feeding to pigs.

Source: Feedipedia; Animal feed resources and information systems. http://www.feedipedia.org/

Exercise 3: Criteria to categorize pig feed (time/duration: 1 hour)

Participants are asked to use flip charts to:

- List any three criteria used to group/categorize feed samples (e.g. by-product, forage, main nutrient supplied, etc.).
- Discuss and name the most abundant nutrient in three feeds brought by the facilitator.
- Identify the category of pigs that better utilize each of those feeds. Explain why

Table 8. A model of how to report the results of the exercise

Feed sample	Criteria used to categorize feed	Most abundant nutrient (e.g. protein, energy)	Category of pigs preferred (e.g. weaners, growers, pregnant sows)	Why you recommend for that category
Maize bran	By-product	Energy	All	Low fibre content
Feed 1				
Feed 2				
Feed 3				

Session 3 Crop residues

Objective: Help participants understand the value and the limitations of crop residues.

Time/duration: 4 hours

Instructions: This section should be taught by an extension officer, animal production technician or veterinarian who is well versed with the use of crop residues in pig production.

Background

In an attempt to reduce the feeding costs, farmers use locally available feed resources. Among those are several crops residues such as sweetpotato vines and non-marketable roots, cassava leaves and roots, and yam leaves, among others. Also kitchen leftovers, including banana peels, are commonly used in pig feeding. However, due to the lack of information that pig farmers and extension staff have on the nutritive value of locally available feed resources, they are frequently not handled in an appropriate way to enhance pig production, resulting in reduced growth rates and poor reproductive performance.

Understanding crop residues used by farmers

The facilitator should begin by asking participants questions in order to learn how much they know about crop residues used in pig production.

- Do you use crop residues for feeding pigs?
- If yes, which crop residues do you use?
- Please rank in scale of 1–10 (where 1 is the lowest and 10 the highest) the most used crop residues in your village. Could also use zero (0) if not used at all.

Table 9. Most available crop residues in your area/region

Crop residues	Cassava		Sweetpotato		Yam		Banana peelings	Others specify
	Roots	Leaves	Roots	Vines	Roots	Leaves		
Rank								

- How do you handle (e.g. do you do any treatment?) the crop residues prior to feeding pigs?
- Which benefits have you observed while feeding pigs with crop residues, compared with other feedstuffs?

Depending on the most common crop residues in the area, the facilitator takes the participants through ways of handling crop residues to improve pig production.

Sweetpotato leaves and tubers (time/duration: 30 minutes)

Farmers in three districts of Uganda (Kamuli, Masaka and Mukono) identified sweetpotato vines as the most preferred crop residue, and this perception could be repeated in other districts. Sweetpotato is mainly grown by smallholder farmers for home consumption; for home consumption; however the surplus can be sold to generate income. Sweetpotato vines are commonly used for feeding different livestock species, especially pigs.

A field of growing sweetpotato.

Credit: Robert Mwesigwa.

A pig feeding on sweetpotato vines.

Credit: Danilo Pezo.

Farmers also feed animals with sweetpotato tubers, especially small roots that are not appreciated in the market, as well as those that become damaged either during harvesting or postharvest, because of the lack of proper storage techniques and/or facilities.

Table 10. Rations for growing and fattening pigs including sweetpotato vines

Ingredients (kgs)	Ration	
	Growing pigs	Fatteners
Rice bran	32	38
Maize	18	16
Ensiled cassava root	30	30
Fish meal	10	6
Sweetpotato vines	10	10
Total	100	100
Weight gain (g)	224	205

Source: Nguyen et al. 2011

Note: The ingredients to use depend on the availability, for instance if rice bran is not available maize bran can be substituted. Sweetpotato roots can substitute ensiled cassava roots.

Table 11. Rations for pregnant and lactating sows that include sweetpotato leaves

Ingredients, %	Stage of production	
	Pregnancy	Lactation
Rice bran	30	44
Maize	30	20
Cassava meal	15	8
Sweetpotato leaves (SPL)	20	20
Fish meal	4	7
Minerals	0.5	0.5
Salt	0.5	0.5
Total	100	100
Ingredients, %	Stage of production	
	Pregnancy	Lactation
Chemical composition		
Crude protein (g/kg DM)	12	14
Crude fibre (g/kg DM)	8.1	8.4
Kcal ME/kg DM	3200	3130

Source: Nguyen et al. 2011.

Managing sweetpotato as a forage crop

Sweetpotatoes can be managed as a semi-perennial forage crop by harvesting the leaves at regular intervals of 30 to 40 days. Under such management, the yield of sweetpotato vines can be five times higher than when the vines are only harvested at the same time as the roots. But root production will be seriously affected, not only in terms of yield, but also in the proportion of roots that satisfy market standards of diameter and size.

Sweetpotato as a dual purpose crop

There are varieties of sweetpotato that are not only good at producing tubers, but also vines, and those are called dual-purpose varieties. To achieve a good yield when sweetpotato is planted as a dual purpose crop for vines and tubers, the sweetpotato should be planted on ridges and vines should be harvested when about 60% of the growth phase of the plant is complete. For instance if the sweetpotato variety takes 150 days for the roots to be ready for harvesting, then the collection of vines could start 90 days after planting. This enhances the production of fodder for animals, without affecting much the yield of tubers. To ensure vine harvest throughout the season, it is advisable for farmers to plant different cultivars (varieties) which mature at different intervals. It also should be noted that the right time to harvest vines while optimizing the yield of tubers and herbage varies depending on the time needed to reach maturity and other characteristics of the sweetpotato cultivar.

Table 12. Sweetpotato leaf yields

Parameter	Unit	Amount
Age of sweetpotato vines at first harvest	Days	40
Harvests / year	Number	9
Fresh leaf yield /acre/harvest	Kg	8000 to 9600
Fresh leaf yield /acre/ year	Kg	72000 to 86400
Leaf yield (DM)/ acre / year	Kg	24000 to 29000

Adapted from: **Hoang et al. (2003).**

Feeding value of sweetpotato

Sweetpotato tubers are rich in starch, vitamin A (particularly the orange flesh varieties), vitamin C and several vitamins of the B complex (niacin, thiamine and riboflavin). The tubers have relatively low levels of protein and fat. In contrast, sweetpotato vines are rich in protein, sugars, vitamins, and relatively high in fibre, but very low in dry matter content (less than 20%), which may limit the amount of sweetpotato vines that animals can eat. On the other hand, animals eating sweetpotato vines may need less water for drinking. Sweetpotato vines can be used to partially replace other protein sources in the diet (e.g. soybean meal), but they should not exceed 13% of the total ration (on dry matter basis) for growing/finishing pigs. The use of sweetpotato vines can be higher in diets for mature females and males (reproductive animals), as in those cases the interest is on maintaining rather than gaining weight. Mature pigs also are better able to use fibre than growing pigs, since their large intestine has reached maximum development.

Table 13. Nutrient composition of sweetpotato vines on dry matter basis

Portion	% in weight	Dry Matter	Crude Protein	Crude Fibre	Starch	Sugars	Ash
Total	100	12.5	20.9	14.9	3.7	8.8	13.5
Stem	26.0	9.6	13.6	20.7	3.9	12.6	13.6
Petiole	23.9	7.9	12.7	16.6	4.5	11.0	18.3
Leaf	50.1	1.36	28.6	11.1	3.2	6.0	10.9

Source: Wolfe (1992).

Limitations to the use of sweetpotato as pig feed

- Raw sweetpotato tubers have compounds called trypsin inhibitors which negatively affect protein digestibility, resulting in poorer weight gains in growing/finishing pigs. However, when the tubers are cooked, those inhibitors are reduced significantly.
- Ensiling can lower the content of the trypsin inhibitors, but does not eliminate them completely, therefore protein digestibility in ensiled sweetpotato is better than raw tubers but not as good as cooked tubers. Sun drying sweetpotato chips also reduces the presence of trypsin inhibitors to levels equivalent to the ones obtained while cooking.
- It is necessary to have a balance between the amino acid and energy content in the diet in order to obtain adequate weight gain. Since sweetpotato tubers are poor in protein and fat, then diets based on the use of sweetpotato tubers need to be supplemented with high quality protein sources (i.e. fish meal), or premixes that contain amino acids, especially the sulphur-rich methionine and cysteine.

As this session comes to the end, the facilitator can ask participants to reflect on what they have learnt. The facilitator may randomly ask the participants questions related to the session.

Cassava leaves and tubers (time/duration: 30 minutes)

This topic introduces participants to the use of cassava leaves and roots as pig feed, emphasizing its feeding value, and how it can be processed in order to get a more efficient utilization.

The facilitator should begin by asking participants questions in order to understand how much they know about feeding cassava leaves and roots to pigs:

- What are the various uses of cassava at your home?
- Do you use cassava for feeding pigs? If yes, which part? Are only leaves, tubers or both? How you give those to the pigs?
- Which varieties do you use?

- Are there benefits you have seen while feeding cassava leaves and roots to pigs as compared to other feeds?

Cassava leaves as pig feed

Cassava leaves have been used for a long time by farmers and can supply many of the nutrients pigs need for growth. However, for cassava leaves to be more efficiently used, they must be stripped off and wilted before offering to pigs. Cassava leaves also can be sundried and ground to form a powdered meal. After drying 100kg of fresh cassava leaves, it is possible to get about 20–25kg of cassava leaf meal.

Production of cassava leaves is dependent on:

- Climate in the area: In the rainy season, leaf production is better than in the dry season; however, if leaves are harvested in the rainy season, it is recommended to dry the leaves under a shade.
- Soil fertility: Leaf production improves when cassava is grown in a fertile soil.
- The variety planted: There is large variation among varieties. If cassava leaves are going to be used for pig feed, look for varieties that have more leaves.

Cassava field

Credit: Brian Kawuma

Cassava leaves can be produced in three ways:

- Growing for roots: The main reason why farmers grow cassava is to produce tubers. However during root harvest, leaves can be collected for feeding pigs.
- Growing for roots and leaves (dual purpose): Cassava leaves can be harvested at least partially at different growth stages of the crop when the roots are still being formed. This increases the leaf yield; however care must be taken while harvesting the leaves because excessive defoliation could lead to the production of small-sized roots. Proper harvesting intervals must be followed, but frequently it is recommended to harvest the leaves every 3 to 4 months, always leaving at least one branch untouched. In cultivars with a short growing cycle (9 months long), leaves could only once before harvesting the roots, while in slow growing cultivars (those that require more than 9 months) leaves can be collected at least twice before harvesting the roots.
- Growing for leaves only: When the main purpose for growing cassava is only to produce leaves, cassava can be planted closer together (1 m × 1 m or 1 m × 0.5 m). With this spacing almost 5000 to 10,000 plants are planted per acre, respectively, as opposed to 1500 to 500 plants per acre with the spacing of 2 m × 1 m, and 2 m × 2 m, respectively. Leaf harvesting is started at 4 months after planting, and followed later by leaf harvesting at 3 month intervals.

Feeding value of cassava leaves

Proteins: Cassava leaves are a good source of protein. The protein content of younger cassava leaves can reach as much as 30% on a dry matter basis, whereas it normally is 25% in mature stages.

Vitamins: Cassava leaves are rich in vitamins (A and C) and minerals (Calcium, Magnesium, Iron, Manganese and Zinc).

Fibre: Cassava leaves have some fibre which can affect pig growth if consumed in large quantities.

Potential toxicity: Cassava leaves and roots also have a toxic compound that releases cyanide which affects growth. The cyanide content is greater in the leaves than in the roots, and is particularly high in the bitter varieties. In the case of the roots, most of the cyanide is in the peelings.

The case of cassava leaves

Fresh cassava leaves contain a compound that after being eaten releases a toxic called hydrogen cyanide in the stomach. The provision of the supplement methionine in a premix not only helps to boost growth and metabolic functions, but also helps to detoxify the hydrogen cyanide. Ensiling cassava leaves also reduces the toxic cyanide. Supplementing diets with ensiled cassava leaves with methionine and lysine increases the performance of pigs.

Current farmer practices

Farmers usually feed fresh cassava leaves and sweetpotato vines to pigs without limiting the animal. This is not the best practice, since fresh crop residues contain high levels of anti-nutritional factors—trypsin inhibitors in the case of sweetpotato tubers and vines, and cyanide glucosides in the case of cassava leaves. If these crop residues are offered fresh to pigs, the amounts to be offered should be limited. To use these residues in greater quantities, it is advised to sun-dry partially, ferment, boil or ensile sweetpotato vines and cassava leaves before including them in pig diets. These treatments reduce the content of anti-nutritional factors, resulting in increased feeding value.

How to reduce cyanide content

The cyanide content in the leaves is significantly reduced by drying partially under the sun or shade (wilting). To speed up wilting, the leaves should be extended on the ground and turned regularly to prevent spoilage. Chopping the leaves helps to accelerate wilting. The latter is more relevant when the purpose is to produce cassava leaf meal; in that case after chopping the leaves, uniformly spread the leaves over the drying area to facilitate quick drying. Once well dried, leaves are collected and grinded into a meal. The meal can be stored in bags or sacks. Dried cassava leaves and cassava leaf meal have excellent storage qualities. They can be kept in dry places for more than a year and used when necessary.

Use of cassava leaf meal in pig feeding

The use of cassava leaf meal in pig diets is not a common practice for smallholder pig producers in East Africa. If farmers opt to use cassava meal it should not exceed 10% in compounded pig rations (concentrates). In other words, in a 10 kg ration only 1kg of cassava leaf meal should be included. When higher levels of cassava leaf meal are used, pigs will not grow well.

Banana peels (time/duration: 30 minutes)

Banana peels are the by-products of household consumption, as well as banana processing, such as the production of banana beer or banana chips. Banana peels are available in large quantities in populated areas or near banana processing plants. Feeding banana peels to livestock is an effective option for handling waste as it transforms inedible residues into high quality food products such as pork, beef and milk. Though banana peels are used in feeding pigs,

most farmers don't follow proper feeding strategies to enhance pig productivity. This session gives guidelines on the proper use of banana peels as pig feed.

The facilitator should begin by asking participants questions in order to evaluate their experience of feeding banana peels to pigs:

- Do you produce and use banana peels in your household? How do you use it?
- Do you use banana peels to feed pigs?
- If yes, how do you process the peels prior to feeding pigs?
- Have you observed any benefit while feeding banana peels to pigs as compared to other feed stuffs?

Nutritional attributes

Banana peels contain some protein (less than 6%) and variable quantities of starch and sugars, but are bulky and depress the digestibility of nitrogen. The nutrient content depends on the stage of maturity. Green peels contain about 40% starch that is transformed into sugars during ripening. The peels of ripe bananas can be fed to growing pigs up to 20% of the diet on a dry matter basis without depressing growth, but higher levels result in poor growth. The energy content of ripe banana peels is higher than that of green bananas.

Potential constraints

Tannins are the most relevant anti-nutritional factors present in banana peels. They reduce the palatability of the peels and are responsible for the astringent taste in immature banana fruits. The tannin content is reduced as the fruit ripens. Feeding bananas that have been subjected to pesticide application may result into toxic residues in animal tissues; therefore, their use should be restricted, unless they are soaked in water before fed to pigs.

Recommendation

Since fresh banana peels are a bulky feed with low energy value and depress the digestibility of nitrogen, it is necessary to:

- Provide energy and protein supplements.
- Offer fresh banana peels in excess as a means to raise intake by 20 to 30%. However, carcass yield will decline because of the increase in the size of the digestive tract, and this will affect the commercial value of the pig.
- Dry the banana peels to increase the energy concentration of the ration. However, there is a cost to dehydration.
- Provide feed supplements such as maize bran. Supplements increase the growth rate, improve the feed conversion ratio and carcass yield, but the level of fat also will increase.
- In practice, the choice of feeding systems or level of supplements is determined by economic considerations, i.e. the price of the feed supplement in relation to the added value of the carcass.

Note: Although farmers perceive banana peels to be of low nutritional quality, they are commonly used by smallholder farmers, especially in areas where bananas ('matoke') is a common component in the household diet.

Case Study: Banana peels as a feeding strategy

Discuss the following case with participants to review what they've learned so far:

Kangume Martha of Magere town has been feeding pigs on banana peels for a while, but she complains that her pigs are not doing well.

- What could be the problem?
- How can she increase the performance of her pigs fed on banana peels?

Yams (time/duration: 30 minutes)

Yam is mainly cultivated for human consumption. It is a tropical root that grows extensively in West Africa and to a lesser extent in other tropical areas including Uganda. Yams vary in their nutrient composition depending on the species and cultivars. The major component in yam tubers is starch (carbohydrate), with a small proportion of sugars. Yams have a relatively high percentage of tryptophan, but are deficient in lysine and other sulphur-containing amino acids.

The yam plant

Credit: Brian Kawuma

The facilitator should begin by asking participants questions in order to understand how much they know about feeding yams to pigs:

- Do you use yams for pig feeding? If yes, how?
- Which varieties do you use?
- Have you seen any benefits while feeding yams to pigs as compared to other feed stuffs?

Nutritional value of yams

The nutritional value of yams varies with the stage of maturity and variety. Taro, or cocoyam, originated in India and Southeast Asia, but is presently cultivated in many tropical and subtropical countries, including Uganda. The starch grains in the tubers are very small, hence taro is highly digestible. The level of crude protein in cocoyam tubers is slightly higher than in yam, cassava or sweetpotato, but its content of essential amino acids is low.

Table 14. Nutrient composition of tubers and leaves in two species of yams (%DM)

Parameters	Water yam (Dioscorea spp.)		Taro (Colocasia esculenta)	
	Tubers	Leaves	Tubers	Leaves
Dry matter	34.2	24.1	26.2	8.2
Crude protein	8.1	12.0	8.7	25.0
Crude fibre	2.6	25.3	1.7	12.1
Ash	5.2	7.9	4.0	12.4
Ether Extract	0.8	2.3	0.4	10.7
NFE	83.3	52.5	85.2	39.8

Source: FAO

Table 15: Performance of growing pigs fed on yam

Tuber	Weight (kg)	Weight gain (g/day)	DM feed conversion	Source
Cooked yam	20–56	580	3.25	Esnaola (1986)
Raw yam	20–43	510	3.40	CIAT (1978)
Cooked yam	20–43	760	2.53	
Raw taro	30–59	590	3.20	Anonymous (1986)

Toxic substances found in yams

Yams, just like other root crops such as cassava and sweetpotatoes, contain substances that limit their utilization. The anti-nutritional factors found in yams are oxalic acid and saponins. The effects of these components and the means of controlling the undesirable effects are described in Table 16.

Table 16. Anti-nutritional factors in yams, their effects and mode of elimination

Toxic substance	Typical levels	Associated effects	Mode of elimination
Oxalic acid	45.3 (g/100g DM)	Precipitation of calcium	Chopping, cooking, heating and fermentation
Saponins	0.53–7.9 (g/100gDM)	Interferes with protein digestion	

Source: Olajidem et al. (2011).

Kitchen leftovers (swill) (time/duration: 30 minutes)

Background

Feeding swill to pigs is a common practice, not only in peri-urban farms, but also in rural settings. In peri-urban areas, the primary sources of swill are households, hotels, restaurants, grocery stores and institutions. The swill also includes leftovers or waste from processing plants, bakeries, dairy companies and slaughterhouses. It is important to ensure that swill is safe and not contaminated with chemicals or pesticide residues. This is sometimes not considered when feeding swill to pigs. This session highlights procedures to follow in order to get the best in pig productivity while using swill. Swill is a low-cost option, but it has quality limitations, and health and sanitary risks.

The facilitator should begin by asking participants these questions in order to assess their use of swill:

- Do you use swill for pig feeding? Why? If you use swill for feeding pigs, how do you prepare it?

- Have you faced any problem while using swill as pig feed?
- Are there benefits you have observed while feeding swill to pigs as compared to other feed stuffs?

Nutritive value of food waste

- Food waste in general has a low dry matter content which may limit intake and animal performance. An exception is bakery residues.
- The nutritive value of swill is quite variable depending on the source. For example, wastes from bakeries could be rich in energy (sugars), but poor in protein, and the opposite will be the case of wastes from slaughterhouses (i.e. blood). Leftovers from poor households are usually of lower nutritive value than leftovers from hotels.

Restaurant leftovers offered to pigs

Credit: Danilo Pezo.

Treatment

Food waste to be fed to pigs should be boiled to reduce the risk of disease. Diseases such as Foot and Mouth disease, African swine fever and swine vesicular disease may spread to other animals if pigs consume contaminated meat. Other pathogens of concern are s*almonella, trichinella* and *toxoplasma*. To avoid these problems, swill with meat products must be boiled at 100°C, and stirred during cooking to ensure that the prescribed cooking temperatures are maintained throughout the container. Cooking is not required in the case of food wastes that do not contain meat, blood or animal organs, such as most bakery wastes.

In most cases when swill is used, there is need for protein supplements. Feeding swill provides a cheap source of feed, but animal growth could be affected if supplements aren't provided, and in some cases animals could face respiratory and digestive problems.

Feeding guidelines

- Make sure you know what is the nutritional value of the swill. If you have the resources to do so, have swill occasionally analysed for nutrients by a laboratory recommended by the extension agent in your area.
- Supplement wet swill with a dry feed such as ground corn or maize bran, and a vitamin and mineral premix to improve animal performance.
- Collect swill from sources where sorting is practiced to separate harmful things such as broken glasses, plastic bags, etc. Supermarkets and institutions may be the best places where sorting is done.
- Avoid swill that is too wet, because those usually result in low dry matter intake, and consequently slow growth rate.

- Follow cooking recommendations if food waste contains meat or meat by-products.

Feed conservation technologies (time/duration: 4 hours, including a practical session)

Feed conservation is the process of preserving fresh feed in good condition so they can be used during periods of shortage, as a means to sustain good animal performance along the year.

The facilitator should begin by asking participants questions in order to understand how much they know about feed conservation:

- How many months during the year do you have access to crop residues such as sweetpotato vines?
- Do you have problems of availability of fodder during the dry season?
- Have you heard of ways to conserve high moisture fodders without mould developing or the feed getting spoiled?

If yes, how these fodders should be conserved?

- How do you ensure the quality of the forage/feed being conserved?
- What could be the benefits of conserving fodder?

Feed conservation methods

- Feeds can be conserved as hay or silage.
- Hay is prepared by partially drying fresh fodder, which is then preserved for use at a later stage; whereas silage is freshly cut fodder that has been compacted and preserved in an airtight container to promote fermentation.

Note: In the case of pig feeding, silage is the most preferred conservation option; therefore this training session will focus on silage making.

Silage making

The facilitator defines what silage is and discusses how silage should be prepared.

Definition: Silage is fresh fodder preserved in air-tight conditions, but other ingredients such as tubers or bran could be incorporated as additives. The fermentation process is similar to the production of banana beer. The material is normally stored in pits or plastic bags (called silos), and the microorganisms present in the silo use the sugars and starch contained by the materials to produce organic acids, which help to stop fermentation and prevent spoilage.

Factors to consider before venturing into silage production

- Feed availability and quality are not constant during the year; therefore there may be periods of excess of good quality fodder, while at other times it is scarce or of inadequate quality.

The process of silage production

Silage production involves the following steps:

- Forage harvesting.
- Transportation to the place where silage will be prepared (i.e. silo / pit / plastic bags).
- Chopping the fodder using a machete ('panga') or a forage-chopping machine.

- Filling the silos in layers with frequent compaction to exclude air.
- Sealing (air tight).

Principles for the preparation of good silage

- The forages used must be of high nutritive value. For that purpose the forage should be harvested at the right stage of maturity. Grasses should be ideally harvested just before flowering.
- The forage must be clean (not contaminated with soil).
- The forage must be chopped in small pieces of about 2 cm in length to facilitate proper compaction.
- The air trapped in the forage must be released before closing the silo. To ensure air-tight conditions, the compaction must be done in layers.
- The area exposed to air after opening the silo should be as small as possible, and the time of exposure should be as short as possible. When the silo is opened to collect some silage, always cover it as much as possible. It's best to prepare silage in batches, with each silo used within 7–10 days.

Advantages of silage

- It can be used when there is not enough fresh fodder to feed the pigs.
- It helps to maintain the animals in good condition even in periods of fodder scarcity. It also helps to prevent losses in quantity and quality of forage/crop residues during periods when the supply exceeds what can be used on the farm.
- It is palatable if properly prepared.
- It reduces pressure on the pasture land, and reduces the need to buy feed during times of scarcity.
- It reduces anti-quality factors and toxic substances to safe levels (i.e. trypsin inhibitor and cyanide in sweetpotatoes and cassava, respectively).

Steps in the preparation of silage using sweetpotato vines and tubers

Step 1. Sort the sweetpotato vines by removing the rotted ones, rotted ones, those that appear yellowish and those with fibrous. Chop the sweetpotato vines into small pieces (about 2 cm in length).

Men cutting and sorting forage.

Credit: Danilo Pezo.

Step 2. Sundry (pre-wilt) the vines in order to reduce the moisture content. However caution should be taken to prevent over-drying. The proper amount of wilting is checked by squeezing a handful of the vines. If water comes out when squeezed, it still has an excess of water. The vines are ready when the material goes back slowly to its original shape after being squeezed.

Step 3: Allow the vines to cool, and mix them with salt and maize bran in the following percentages: 93.5% pre-wilted vines + 0.5 % salt + 6 % maize bran. The facilitator needs to figure out how to measure the proposed percentages of ingredients. Although the addition of a source of carbohydrates (i.e. molasses, maize bran) may help to improve fermentation of sweetpotato vines, their use is more needed when ensiling grasses which have low levels of sugar and starch, like Napier grass. If maize bran is not available, it can be replaced by molasses, rice bran or cassava meal. Another possibility is to ensile sweetpotato vines with part of the non-marketable tubers (such as 70–80% vines, 20–30% tubers); however the tubers have to be chopped/sliced. The tuber slices are then mixed with the chopped vines and salt (about 0.5%). As sweetpotato vines have enough sugars, it is also possible to get good silage without any additives. Another option is to add poultry litter to increase the level of protein in the silo, favouring the action of the microorganisms responsible for silage fermentation.

Table 17. Silage preparation formulas

Formulas for silage preparation (%)	Sweetpotato vines	Maize meal	Rice bran	Sun dried chicken manure	Cassava meal	Salt
1	93.5	6	0	0	0	0.5
2	83.5	6	0	10	0	0.5
3	93.5	0	6	0	0	0.5
4	83.5	0	3	10	3	0.5

A man adding and mixing additives for silage making.

Credit: Robert Mwesigwa.

Step 4: Pack the mixture into pit, plastic or nylon air-tight bags. Make a fist and punch down contents firmly to press out excess air. This has to be repeated several times in the process of filling the bags. Compaction also must be applied if the silage is made in pits, but in that case compaction is done by a group of people jumping on top, or by using a drum filled with water. In big silos, even a tractor or a truck could be used to compact the fodder.

Ensiling forage

Credit: Danilo Pezo.

Step 5: Check the bags for air build up on the first and second day after filling. If bags are puffed, open and squeeze out as much air as possible, then re-close the bags tightly. High temperatures also could be indicative of improper compaction.

Step 6: Store bags in a cool, dry place away from rodents or insects, to prevent bags from becoming punctured. Good quality silage should be ready in 6–8 weeks.

At what age are pigs ready to eat silage?

The appropriate age for pigs to be fed on sweetpotato silage is three months and above. Silage is not recommended for piglets and weaners, because their digestive system is not developed enough to efficiently utilize the silage.

How do you know if the silage is of good quality?

- It has a good, sweet smell.
- The colour is still greenish.
- There is no mould (white or pink fungus).

How long can the silage be stored?

The length of storage depends on the conditions, but if proper steps are followed (well compacted, airtight, no holes) it can be stored for 4–5 months or even longer, with no significant reduction in its nutritional content. It is not uncommon that silage is prepared but isn't needed the same year. In that case, there will be no problem using it the following year if the airtight conditions have been maintained.

How much silage can pigs eat?

The daily allowance of silage for pigs is equivalent to 3% body weight. Table 18 shows the amount of silage that could be offered to animals of different weights.

Table 18. Amount of silage to be offered to pigs, as a function of body weight

Pig weight, kg	20–30	30–40	40–50	50–60	>60
Quantity of silage offered kg/head/day	1.0	1.2	1.5	1.6	1.8

Exercise 4 feed conservation (time/duration: 2–3 hours)

Take the participants through the different steps involved in silage making, with the aim of them gaining experience and a better understanding of the key steps and procedures.

Tools and materials

- Sweetpotato vines/cassava leaves
- Maize bran (not needed if tubers are ensiled)
- Salt
- Panga
- Sisal string
- Plastic bag or plastic sheaths if the silage is made in a silo pith
- Forage chopper/slicer

Case study: Preparation of silage

Before we come to the end of this session, let's analyse what happened to a group called the Kalusoke Pig Farmers. The farmers were trained to make a good quality silage last year, but the silage got spoiled. There was a lot of mould in it, in some areas the silage was of very dark colour, like being burnt,

- What do you think were the possible reasons why the silage got spoiled?
- What steps should have been followed to produce quality silage?
- How can the group know that the silage is of good quality?

Session 4 Strategic supplementation

Objective: Train participants on how to strategically add supplements to the feed of pigs at different stages.

Time/duration: 3 hours (1 hour for exercise)

Instructions: This session should be led by an extension agent, animal production technician, veterinarian or experienced farmer.

Background

Strategic supplementation refers to the provision of nutrients that are missing in the basal diet. The basal diet is the main component of the ration, and in most smallholder pig farms it is comprised of crop residues such as sweetpotato vines, cassava leaves, yam leaves, some grasses and crop weeds, and kitchen leftovers such as banana peels and even fruit. None of the above feeds alone can provide all the nutrients required by a given category of pigs. Pigs, being single stomached, have difficulty digesting the fibre contained in forages such as Napier grass and fibrous crop residues. Therefore those cannot be the only feed; also pigs have special needs for amino acids that aren't provided by the forages in sufficient amounts.

Another concept to be considered for defining strategic supplementation is that nutritional needs of pigs vary at each stage of growth. However, it is common to find that many pig farmers provide the same diet for all animals on the farm, ignoring that a diet or a supplement that is good for fattening pigs (weighing more than 50 kg) is not sufficient to meet the nutritional demands of suckling piglets and weaners, or sows under flushing (supplemented to assure high conception rate) or lactating sows.

Supplementing becomes important:

- When the nutrient content of the basal diet does not match the nutrient requirements of the pigs
- When pigs are stunted, show poor body condition, or are growing slower than normal
- In the case of flushing or lactating sows, and weaning piglets.

Nutritive feed supplements/additives

The health and productivity of animals can be improved by supplementing with feed additives (providing either nutrients or factors that help pigs to maintain good condition). In general, feed additives are expensive, but are required in small amounts. Due to health issues, consumer demands and regulations, the use of some additives such as antibiotics and hormones are currently restricted or even banned. Additives are usually in the form of premixes containing vitamins, minerals, amino acids and enzymes.

Strategic use of amino acids

Pigs require essential nutrients to meet their maintenance, growth, reproduction and lactation needs. Some amino acids such as alanine, asparagine, cysteine and proline are referred to as 'non-essential' because they are synthesized/ produced by the animal in adequate amounts, while the ones considered as 'essential' are not synthesized at an adequate rate, therefore should be supplied in the diet. For example, the protein present in maize bran does not contain adequate levels of lysine and tryptophan, both essential amino acids. Therefore, in order to get adequate weight gain, these amino acids need to be strategically supplemented to pigs receiving maize bran and kitchen leftovers or sweetpotato vines. If these amino acids are not provided as supplements, then the farmer has to provide an animal protein source rich in those amino acids or must increase the level of crude protein in the diet.

Strategic use of enzymes

Enzymes can be added to locally available feed resources or commercial concentrates. In young piglets, enzymes are used to compensate for the less developed enzyme potential, and consequently increase the digestibility of feeds. Enzymes improve the balance of micro-organisms in the gut. Cellulases and hemicellulases for example are enzymes that cause the release of nutritious components by breaking down the fibre (plant cell walls) present in plant feeds. In maize, the calcium content is low and phosphorus is largely unavailable for digestion; therefore, the inclusion of phytases enhances the utilization of minerals such as phosphorus, and eventually results in a better growth rate.

Strategic use of fruits as vitamin supplements

In many cases, farmers are not able to consume or sell all the fruit produced at their farm, therefore if not used for animal feeding those will get spoiled. Most fruits are rich in vitamins and minerals. Other fruits such as avocados are good sources of carbohydrates and fat as well. Feeding fruits to pigs can help meet most vitamin requirements of pigs and costs less than commercial vitamins.

Pig feed can be supplemented using a variety of fruits such as avocado, paw paws and jack fruit.




Credit: Geoffrey Beyihayo.

Precaution when feeding fruits:

- Use proper feeding structures/feeders to avoid spoiling of feed.
- Chop fruit into small pieces that can easily be picked and chewed by the animal.
- Source of fruit should be free from parasites.

Commercial supplements

High-quality commercial feed supplements are costly, hence should be used cautiously to prevent economic losses. For example, if a farmer uses a special diet for piglets, then only suckling pigs should have access to that more expensive feed. Therefore, there should be a division or 'creep area' in the enclosure where the lactating sow and its piglets are kept, so only piglets have access to the special feed. Weaners also should be fed separately from the other pigs; otherwise bigger pigs will dominate them and will eat the high quality feed instead.

Some of the ingredients used to make commercial rations to supplement pigs.

Sunflower meal

Vitamin-mineral premix

Maize bran

Fish before milling

Credit: Geoffrey Beyihayo.

Using whey (spent milk) as a supplement

Whey is a by-product of milk processing to make cheese. It is rich in energy and minerals. Since cheese making is not common in Uganda, the current availability of whey is low. However, its use is expected to grow given the increase in the number of milk processing plants, and the change in eating preferences particularly in the urban population. Fresh whey (dehydrated and skimmed) is more palatable than fermented (acid whey), but should be consumed immediately upon delivery so it doesn't spoil. Even though additional research is needed in Uganda to validate the inclusion of liquid or dry whey in pig rations, the practice is common in many other countries.

Session 5 Water use in pig production

Objective: Train participants on the importance of conserving water, and applying low-cost water harvesting techniques.

Time/duration: 1 hour (for discussion) + 3 hours (for the practical session)

Instructions: Facilitator should be someone who has been trained in presenting the session.

Background

Water is an important resource in pig management. It is used for drinking, bathing the pigs, washing pens, and cleaning feed and water troughs. At the same time, water is frequently scarce, especially during the dry season, and should be used efficiently on the farm and in households. Efforts should be made to tap and store water during the rainy season. This is called water harvesting.

The facilitator should begin by asking participants questions in order to understand how much they know about the need of water in pig systems.

- Do pigs need water for drinking?
- For what other purposes do you need water in the household and farm? What about needs for pigs?
- What are the water sources in your community?
- Do you get enough water during the year? If not, what are the major problems you face? How does it affect your pig farm?
- How have you been handling water-related problems?

Importance of water to pigs

Water is important because the body of any animal species contains at least 60% water. The water content in the body is greater in younger animals. Water also is important because:

- It enhances the eating ability of animals.
- It cools down the animal when exposed to high temperatures (Remember: pig are not able to sweat).
- It is needed in the normal bodily functions of an animal.

How does the animal get water?

The animal obtains water from three sources:

- Drinking water
- Water in feeds consumed by the animal such as fresh forages.
- Metabolic water, or water produced in the cells of an animal as part of a body's normal functioning.

How does water leave the body of the animal?

Water leaves the body of a pig through:

- Urine
- Faeces
- Milk
- Breathing

Water requirements for pigs

Water needs for pigs are influenced by:

- Body weight: Water needs increase with body weight. In other words, mature animals need more water than young ones. The composition of the herd should be taken into account when budgeting water needs for a farm.
- Health status: Sick animals usually require more water, especially when suffering from fever or diarrhoea.
- Proportion of protein in the diet: The higher the content of protein, the more water an animal will need.
- High ambient temperature: Pigs need to drink more water in hot weather.

Table 19. Pig water requirement at different growth stages

Class of pigs	Body weight, kg	Litres/day
Piglets	3–9	0.25–1.0
Grower pigs	10–25	1–3
Finishing pigs	25–65	2–5
Non pregnant gilts	65–105	4–10
Lactating sow	65–95	10–20
Boar	65–112	18–30

Key points of supplying water to pigs:

- Consider the different needs at the various stages/weights of the pigs on your farm.
- Don't take water for granted, too little water hurts the pigs and too much is a waste.

When it comes to water, pigs are picky

While providing water to pigs, most farmers pour the water in the troughs and it remains there for a long time, and can become dirty and smelly. Pigs won't drink dirty and stinky water. Also, putting too much water in a trough at a time is a waste, since pigs will start playing in it and eventually wet the feed. Therefore, only enough water should be put in the trough. When it's empty, the farmer should refill it accordingly. The water troughs also should be kept clean. In the market can also find automatic drinkers with nipples.

Water harvesting technologies

Why is water harvesting important?

Water harvesting is important to safeguard the homestead and the animals from water shortages during the dry season. Plenty of water is usually available during the rainy season, hence it is necessary to store running water from the rooftop and prevent/control water runoff.

How does one harvest water?

A pit is dug using hand hoes, and then a black polythene sheet is placed such that it covers the entire pit. One of the main water losses in the pit is due to evaporation; therefore the pit should be located under a shade to reduce such losses. The volume of water kept in the pit depends on the pit size. For instance if the pit is 1 cubic meter (2 m long × 0.5 m wide × 1.0 m deep) it can accommodate 1000 litres of water.

Tools and materials

- Black polythene sheet: to line the bottom of the pit
- Hoe: to dig the pit
- Gutter: to collect water from the rooftop
- Plastic pipe: to connect water from the roof top to a reservoir

Case study: A farmer in water distress

Before we come to the end of this session, discuss what happened on Rukyamuzi's pig farm. Last year, he was trained on water harvesting technologies which he did not put into practice, although he had a nearby water source. Due to an increase of humans and animals in his village, the water is now scarce and his pigs aren't getting enough water.

- What could happen to his pigs in the long run?
- How he can correct the situation?

Module summary

Feeding is one of the major constraints in smallholder pig production, and the most relevant component in term of costs of production. Variations in the availability and quality of feeds due to seasonality, fluctuation of prices or other factors can result in an unstable supply. To achieve optimal performance of pigs, the farmer should ensure an adequate supply of feed along the year and apply strategic supplementation to compensate for missing or inadequate nutrients. This module also highlighted the use of crop residues for improving pig production. Emphasis was given to processing for increased utilization. Water as a nutrient also was stressed in relation to efficient use and harvesting technologies.

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