



Value Chain Alliance for Livestock Upgrading and Empowerment



Training Manual on Pig Feeds and Feeding



Zimbabwe
AGRICULTURAL
GROWTH
Programme



European Union

Table of Contents

| | |
|---|-----------|
| List of Tables | 5 |
| List of Figures | 6 |
| Introduction | 7 |
| Information and instructions to the trainer. | 7 |
| Users of the manual | 8 |
| Presentation methodology | 8 |
| Assessment | 8 |
| Pig Feeding and Nutrition security | 9 |
| Unit One | 10 |
| 1. Pig Production husbandry issues | 10 |
| 1.1 Objective. | 10 |
| 1.2 Outcomes | 10 |
| 1.3 Animal husbandry | 10 |
| 1.4 Activity | 11 |
| Unit Two | 12 |
| 2. Introduction to nutrients in pig feeding | 12 |
| 2.1 Objective. | 12 |
| 2.2 Outcomes | 12 |
| 2.3 Introduction | 12 |
| 2.4 What is feed? | 12 |
| 2.5 Nutrients | 13 |
| 2.6 Water | 14 |
| 2.7 Protein | 14 |
| 2.8 Carbohydrates and Fats/Lipids. | 15 |
| 2.9 Vitamin | 15 |
| 2.10 Minerals | 15 |
| 2.10.1 Calcium and Phosphorus. | 16 |
| 2.10.2 Sodium and Chlorine | 16 |
| 2.10.3 Other minerals | 16 |
| 2.11 Activities | 17 |
| Unit Three | 18 |
| 3. Nutrient requirement and making a complete feed. | 18 |
| 3.1 Objective. | 18 |
| 3.2 Outcomes | 18 |
| 3.3 Introduction | 18 |
| 3.4 Feeding standards | 18 |
| 3.5 Nutrient requirements | 19 |
| 3.6 Body Maintenance requirement: | 19 |
| 3.7 Growth and productivity requirement | 19 |
| 3.8 Fattening requirement: | 20 |
| 3.9 Reproduction requirement: | 20 |
| 3.10 Milk production requirement | 20 |
| 3.11 Ration formulation. | 21 |
| 3.11.1 Principles of formulating rations | 21 |
| 3.12 Activity | 24 |
| Unit Four | 25 |
| 4.0 Feeding different classes of pigs | 25 |
| 4.1 Objective. | 25 |
| 4.2 Outcomes | 25 |
| 4.3 Feeding under intensive production system. | 25 |
| 4.4 What is feeding? | 27 |

Training Manual on Pig Feeds and Feeding

| | |
|--|-----------|
| 4.5 Aims of feeding pigs? | 27 |
| 4.6 Which types of feeds | 29 |
| 4.6.1 Conventional feeds | 29 |
| 4.6.2 Non-conventional feeds | 29 |
| 4.7 Feeding different classes of pigs | 29 |
| 4.7.1 Boars, Dry sows and Gilts | 30 |
| 4.7.2 Practical management before breeding | 30 |
| 4.7.3 Feeding during pregnancy | 30 |
| 4.7.4 Lactating Sow and Her Piglets | 31 |
| 4.7.5 Management of piglet | 31 |
| 4.7.6 Growing and finishing stages | 31 |
| 4.8 Activity | 32 |
| Unit Five | |
| 5.0 Marginal feeds | 33 |
| 5.1 Objective | 33 |
| 5.2 Outcomes | 33 |
| 5.2.1 Integrating Pig Production | 33 |
| 5.2.2 Use of left-over food from kitchens | 33 |
| 5.2.3 Pasture/Forage Feeding | 33 |
| 5.3 Mycotoxins | 34 |
| 5.4 Feed wastage | 35 |
| 5.5 Feed records | 36 |
| 5.6 Activity | 36 |
| 6.0 References | 36 |

List of Tables

| | |
|---|----|
| Table 1: Protein and energy requirements at different production stages | 20 |
| Table 2: Suggested ways of mixing on farm feeds. | 22 |
| Table 3: Feed quantities to be offered to pigs | 25 |
| Table 4: Pig production parameters | 26 |
| Table 5: Summary of age, body weight, feed amount requires and type of feed | 31 |

List of Figures

| | |
|---|----|
| Figure 1: Expected sow performance under an intensive production system under the best animal husbandry practices..... | 11 |
| Figure 2: Practical demonstration of the Pearson square method of feed formulation..... | 21 |
| Figure 3: A schematic presentation of a typical pig production unit with all class pigs under different production stages | 24 |
| Figure 4: A guide to body condition score in pigs..... | 26 |
| Figure 5: Standard sow production cycle | 28 |
| Figure 6: Effect of mycotoxins in pigs (Source: https://www.biomin.net/species/pigs/mycotoxins/) | 33 |

Introduction

The quality of feeds offered to pigs play an essential role in influencing their overall performance. A pig is a monogastric animal hence special attention to amino acids availability in the feed is very important. Fast growth rate can be achieved through addressing nutritional deficiency and ensuring proper feeding is carried out. Providing high nutritive value feeds to pigs is associated with fast growth, increased litter size, high birth weight, minimal occurrence of rants, reduced unproductive days, reduced age to reach puberty and slaughter weights hence the overall profitability of the pig enterprise.

For smallholder farmers to be profitable, they should pay extra attention to quality of feed ingredients and the body condition score of their animals. The performance of smallholder pig producers is suboptimal but with great potential if proper pig feeds and feeding activities are embraced. Most small to medium pig farmers have been operating with limited understanding of pig nutrition and its importance.

This training manual is designed to equip farmers with basic knowledge on pig feeds, how to feed to meet nutrient requirement for maintenance, growth and reproduction. On-farm feed production is also discussed to ensure nutrition adequacy and feed security at farm level. The target group is the small to medium farmers (including young and women farmers), lead farmers (anchor), farmer groups, Business Management Unit (BMU), syndicate or cooperatives and integrators, who will be trained in this program to enhance their skills at individual and organizational levels. The trainees are expected to utilize the skills in their respective activities in Pig Value Chain. The use of high protein non-conventional feed resources in pig feeding will have a positive contribution to the overall growth and development of pig value chain in the country.

Information and instructions to the trainer

This manual should be used purely as a facilitator's guide. The sessions under each module are presented with an objective(s) to facilitate the assessment of participants' understanding and depth of knowledge at the end of each session. The manual also provides some background information on each session. The information is also meant to aid the facilitator in the preparation for the session. However, all users of this manual must study and research into the content of each unit before the presentation. Start each sub-topic and group activity by explaining the objective and learning outcomes expected of them, and ensure they are met.

The session should be interactive, participatory, lively and interesting. Let the participants express themselves in vernacular language as it helps them to understand the concepts. Encourage them to ask questions especially on concepts that they don't understand. Switch to either English or vernacular language when you find some or all of them do not understand you in one of the languages.

Start the session with greetings, welcoming remarks introduce yourself. Trainees will complete the end of course Evaluation Sheet on the conduct of the session by you, the trainer. Ensure you have the necessary stationeries for the trainees and equipment and materials: projector, flip charts or whiteboard, whiteboard markers, marking pens, and handouts. Be time conscious as you facilitate the Session

The Manual is divided into five units which are a) Pig production husbandry issues, (b) Introduction to nutrients in pig feeding, (c) Nutrient requirement and how to produce a balanced pig feed, (d) Feeding different classes of pigs, and (e) Nutrition security and alternative feeding strategies.

Users of the manual

The manual is intended to be used by facilitators at various levels of the pig value chain in Zimbabwe.

Presentation methodology

The methods of presentation outlined in the manual are suggested as a guide to the facilitator. The facilitator is expected to use his or her judgement in selecting the appropriate method or combination of methods in presenting each session.

Assessment

At the end of each session, the facilitator is expected to assess/evaluate the participants' understanding and level of knowledge by using a simple question and answer session as appropriate. It is advisable to assess participants at the end of each unit. The facilitator is given a complete discretion in determining the kind of questions to be asked. However, all assessments must relate to the session.

Pig Feeding and Nutrition security

Participants will learn about pig feeds and feeding. Participants will be taught different nutrients supplied by each diet. The importance of such nutrients to the health and productivity of the animal will be emphasised. Furthermore, each participant will be assisted to identify feedstuffs that can be used to feed different classes of pigs. The Module is divided into five units as follows:

Unit 1: Pig production husbandry issues

Unit 2: Introduction to nutrients in pig feeding

Unit 3: Nutrient requirement and how to make a balanced pig feed

Unit 4: Feeding different classes of pigs

Unit 5: Nutrition security and alternative feeding strategies

Overall Objective

By the end of the training, participants will be able to identify feedstuffs with adequate nutrients, explain and analyse the importance of nutrients in influencing animal performance, blend these feedstuffs in a complete ration which can be fed to specific classes of pigs to maximise productivity.

UNIT

1

PIG Production husbandry issues



1. Pig Production husbandry issues

1.1 Objective

- To introduce learners to the pig production husbandry issues.
- To help learners to set performance targets.
- To help learners to set up a road map to achieve the set performance targets.

1.2 Outcomes

- Learners should be able to identify animal husbandry issues that affect profitability.
- Learners to set their performance targets.
- Learners should identify nutritional impediments affecting the performance of pigs.

1.3 Animal husbandry

- Farmers cannot prosper when pigs are not healthy and reproductively fit.
- The profitability of the farm is a good indicator of the well-being of its animals.
- Profits provide an economic incentive for good husbandry.
- Management and husbandry practices including the following:
 - Providing facilities to protect and shelter pigs from weather extremes while protecting air and water quality in the natural environment.
 - Providing well-kept facilities to allow safe, humane and efficient movement of pigs.
 - Providing personnel with training to properly care for and handle each stage of production.
 - Providing access to good quality water and nutritionally balanced diets appropriate for each class of pigs.
 - Observing pigs to make sure basic needs for food and water are being met and to detect illness or injury.
 - Developing herd health programs with veterinary advice.
 - Providing prompt veterinary medical care when required.
 - Using humane methods to euthanize sick or injured swine.
 - Maintaining appropriate biosecurity to protect the health of the herd.
 - Providing transportation that avoids undue stress caused by overcrowding, excess time in transit, or improper handling during loading and unloading.
- Figure 1.1 shows the expected sow performance under an intensive production system practicing good animal husbandry.
- Proper feeding ensures that sow remains in production for many years.
- The target performance shown in Figure 1.1 can be achieved if the sow is offered all nutrients in their correct proportion.
- Failure to give a sow the correct diet to meet its nutrient requirement increases the number of unproductive days resulting in reduced productivity.
- Furthermore, if the required nutrients are not offered the sow may fail to produce more than 12 piglets per farrowing as well as to achieve greater than two farrowing per year.

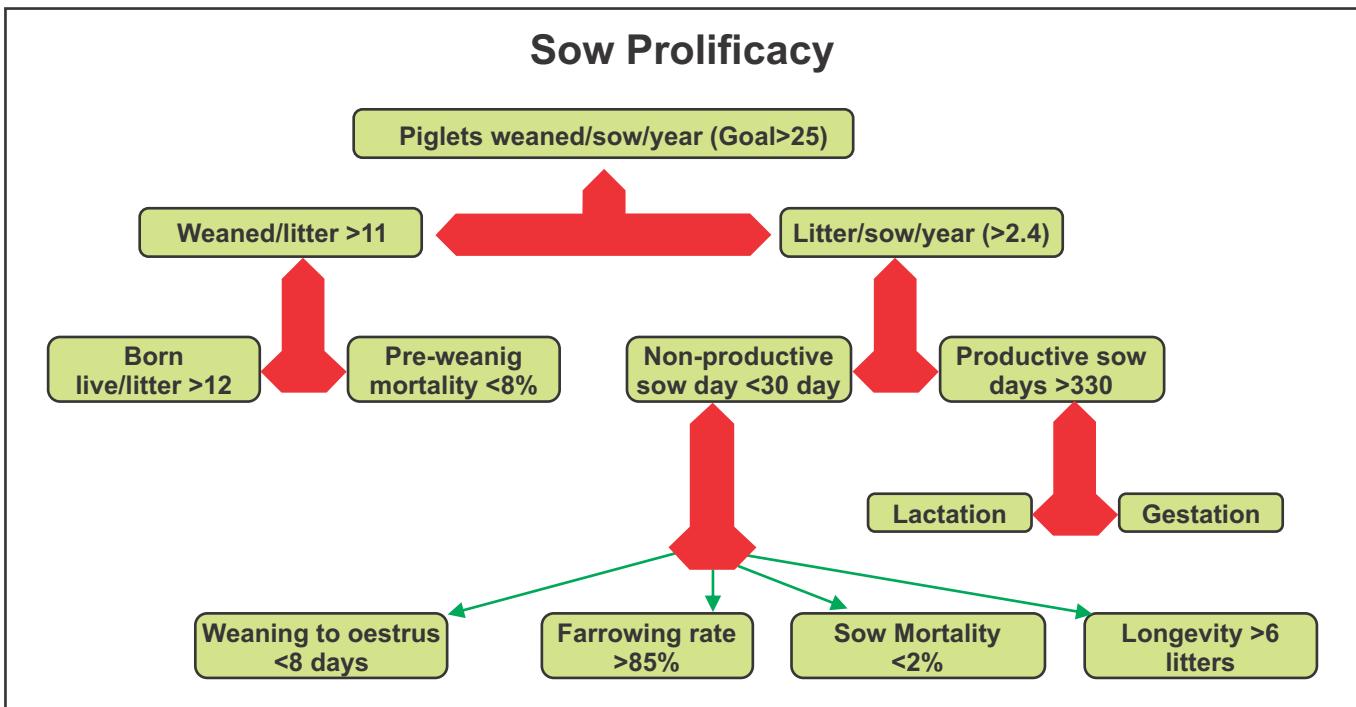


Figure 1: Expected sow performance under an intensive production system under the best animal husbandry practices.

1.4 Activity

Task 1: Each participant to list all their performance figures

Task 2: As a group compare your performance to expected target under intensive system

Task 3: Each participant should identify areas of improvement with regards to animal husbandry practice discussed under this unity

UNIT
2

Introduction to nutrients in pig feeding



2. Introduction to nutrients in pig feeding

2.1 Objective

- To introduce learners to the required nutrients for optimum performance of pigs.
- To classify nutrients and their sources.
- To inform learners of the effects of nutrient supply to pigs.

2.2 Outcomes

- Learners should be able to list all nutrient required in pig feeding
- Learners to identify sources of such nutrients in their location
- Learners list signs of nutritional deficiencies in pigs

2.3 Introduction

- Feed is the major production cost, which account for at least 80% of the total cost of producing pigs and is the largest fraction of variable cost.
- Pigs are monogastric and cannot utilise high fibre diets efficiently
- The feed must contain the nutrients in the right quantities and a correct method of feeding should be used.
- It is therefore important to provide a balanced diet and correct feeding standard. Farmers who fail to adhere to correct feeding at each production stage may not be able to realise profits and income generation will suffer.
- Pig farmers should aim to minimize feed costs if profits are to be maximized. Hence, it may be necessary to use the least-cost high performing ration.
- Successful farmers manipulate feed ingredients to maximize productivity and for the enterprise to meet its set objective of profit maximization.
- Therefore, this is central to the maintenance of a stable and sustainable pig production enterprise.

2.4 What is feed?

- Feed or feedstuff is all edible material, which after ingestion by the animal is capable of being broken down into simple molecules called nutrients.
- Nutrient is the name given to the different constituents of feed that are important and are utilized by the body.
- Most feedstuffs contain several kinds of nutrients, but a single feed cannot provide all the nutrients required by the pig in their right proportions. Hence, the need to use a variety of ingredients.
- These feedstuffs are broadly grouped into five namely:
 - Energy sources, e.g. maize, sorghum, cassava, millet etc.
 - Protein sources, e.g. soybean meal, sunflower cake, cotton seed meal fish meal etc.
 - Mineral Supplements, e.g. commercially produced mineral premix etc.
 - Vitamin supplements
 - Feed additives or non - nutritive additives, e.g. anti-biotics, flavours, etc.
- A total mixed ration should have all the above feedstuffs to satisfy the nutrient requirement for each stage of production.
- Every stage of production, level of productivity, age, breed and physiological status demands a specific ration hence level of inclusion of these feedstuffs varies accordingly.
- There is no universal feed for all classes of pigs.

2.5 Nutrients

- Nutrients are any food constituents or groups of food constituents of the same general chemical composition that aid in the support of life.
- The nutrients obtained from feedstuffs are important for energy release, growth, repair, various secretions, storage, transport, maintenance of internal osmotic and pH environment.
- This implies that nutrients in feed are responsible for preserving life.
- Pigs require six categories of nutrients namely protein, carbohydrates, fats, vitamins, minerals and water.
- These are digested, absorbed and assimilated nutrients are utilised to satisfy metabolic needs i.e. being transformed into body elements of the animal.

Training Manual on Pig Feeds and Feeding

- If the six nutrients are not provided in sufficient quantities suboptimal reproduction, stunted growth and poor animal productivity will be experienced.
- Furthermore, if these shortages of nutrients become critical metabolic or deficiency diseases and death may occur.
- It is therefore mandatory that any diet given to any animal should have these nutrients to remain healthy and productive.
- Deficiencies in nutrient supply in female animals are like contraceptive pills which can stop the oestrus cycle, a condition called nutritional anoestrus.

Table 1: Raw materials and their nutrient composition

| SOURCES | Raw Material | DM % | CP % | ME (MJ/kg) | Fibre % | Lysine (g/kg) | Meth + cyst (g/kg) | Ca% | P% |
|-------------------|---------------------------|------|------|------------|---------|---------------|--------------------|-----|------|
| ENERGY | White maize crushed | 87.3 | 9.8 | 14.2 | 2 | 2.5 | 2.3 | 0.3 | 2.7 |
| | Wheat feed crushed | 88 | 12.4 | 12 | 6 | 3.1 | 2.1 | 0.5 | 3.5 |
| | Sorghum crushed | 88 | 10.8 | 12 | 4 | 2.1 | 1.6 | 0.5 | 3.5 |
| | Millet | 86 | 12.1 | 13 | 9.3 | | | 0.6 | 3.1 |
| | Brewers Grain air dried | 26 | 21.8 | 11.5 | 17 | 6.8 | 3.4 | 1.7 | 3.7 |
| PROTEIN | Soyabean meal | 88.6 | 44 | 10.5 | 7 | 28.5 | 7.9 | 3.5 | 6.8 |
| | Soyabean Full Fat (whole) | 88 | 40 | 14 | 5 | 28.5 | 7.9 | 3.5 | 6.8 |
| | Cotton seed cake | 94.4 | 37.9 | 11.1 | 17.1 | 17.1 | 5.2 | 1.9 | 12.4 |
| | Sunflower cake | 89.8 | 33.6 | 9.6 | 26.5 | 10.1 | 7.6 | | |
| | Edible beans | 90 | 26.7 | 13.3 | 9.1 | 15.8 | 1.8 | 1 | 5.5 |
| | Groundnut meal | 90 | 34.5 | 14 | 9 | 16.4 | 5.6 | 2.9 | 6.8 |
| | Fish meal | 91.1 | 69.3 | 14.2 | 0 | 48.2 | 15.2 | 79 | 44 |
| | Meat and bone meal | 88 | 60 | 13 | 6 | 22 | 6.5 | 120 | 58 |
| MINERAL & VITAMIN | Limestone flour | 100 | 0 | 0 | 0 | | | | |
| | Rock salt | 100 | 0 | 0 | 0 | | | | |
| | Di-Calcium Phosphate | 100 | 0 | 0 | 0 | | | | |
| | Vitamin mineral mix | 100 | 0 | 0 | 0 | | | | |

2.6 Water

- A newly born animal is 80% water, while at slaughter water content in the body of the animal is 50%.
- Pigs require approximately 3 to 45 litres of water/head/day.
- The amount of water required per day depends on:
 - Animal factors such as breed, age, sex and physiological status.
 - The weather conditions.
 - Dry matter of feed provided.
 - Type of feed provided
 - Level of feed eaten
- It is necessary for all body functions such as digestion, excretion, circulation and is the media in which all biochemical reactions occur etc.
- Dehydration and death will occur once the provision of clean fresh water is compromised.
- It is a must to supply water to pigs all the time.

2.7 Protein

- Protein is a nutrient required in large quantities which is essential in the building of body muscle mass.
- It is commonly found in animal products, though it is also present in other sources, such as oilseeds.
- Amino acids are the building blocks of proteins, and proteins are the building blocks of muscle mass,
- Proteins are needed for growth and body repair. The sources of protein include feedstuffs of animal origin: Fish, Blood meal, Meat and bone meal. Feedstuffs of plant origin: Soybean meal, Cottonseed cake, Sunflower cake.

2.8 Carbohydrates and Fats/Lipids

- For maintenance of normal body functions.
- The sources of energy have a lot of carbohydrates (starch and sugars) or fat:
- These include: Cereal grains: Maize, Sorghum, Millet, Wheat, cereal processing by-products: Maize bran, Wheat bran, Rice bran, Roots and Tubers: Cassava, Sweet potato, Yams, Fruits: Banana, Jack fruit, Avocado
- Animal fat is also a good source of energy.

2.9 Vitamin

- These are important for the maintenance of normal health, growth, proper skeletal development and normal reproduction.
- The sources of vitamins for pigs include green fresh forages and bought in sources such as vitamin premixes.
- The most critical vitamins required in pig's production are vitamins A and E.
- Vitamin A is very important for growth and epithelial tissue integrity.
- Deficiencies are associated with weight loss, depressed immune function, night blindness, hair loss and most importantly decreased fertility.
- Vitamins premix used in blending diets meets daily requirements for pigs.
- Vitamin E is also very important since deficiencies cause depressed immune function and depressed fertility

2.10 Minerals

- Minerals are grouped into two groups namely macro and micro minerals. This grouping is not according to importance but the quantities required.
- Macro minerals are expressed in percentage terms while micro expressed in parts per million (ppm) or mg/kg.
- They are very important for strong bones and normal body functions.
- The sources include: browse and forage legumes, bone ash, common salt, soil – vitamin-mineral premix, limestone and dicalcium phosphates.
- There are seven important macro-minerals which should be supplemented to pigs namely:
 - Calcium
 - Phosphorus
 - Sodium
 - Chlorine
 - Magnesium
 - Potassium and
 - Sulphur.
- There are eight micro-minerals namely;
 - Copper,
 - Molybdenum,
 - Cobalt,
 - Iron,
 - Iodine,
 - Zinc,
 - Manganese and
 - Selenium
- Micro mineral deficiency is less common except iron than energy, protein and macro-minerals deficiencies.

2.10.1 Calcium and Phosphorus

- Calcium and phosphorus are interrelated, with almost all calcium found in the body and most of the phosphorus being found in the skeletal tissues.
- Diets with less of the calcium and phosphorus may delay growth and development in pigs and predispose them to metabolic bone diseases such as rickets.
- In nursing sows, deficiency of these two can cause a reduction in milk production resulting in slow growth rate in piglets
- Most legumes are high in calcium and low in phosphorus.
- For nursing/lactating sows, it is important to supplement calcium and phosphorus
- Pigs feeding on browse formulated diets may need less supplemental phosphorus.

Training Manual on Pig Feeds and Feeding

- Deficiencies in phosphorus result in slow growth, depressed fertility and depraved appetite
- Grain is a good source of phosphorus hence supplementing nursing sows with grain may resolve deficiencies issues.

2.10.2 Sodium and Chlorine

- These are integral components of many body functions
- Salt should be incorporated at 0.2-0.5% of the diet.
- Pigs in deficiency of salt chew wood, lick the soil or consume other unlikely plants and debris
- The salt content in the feed may be increased to 0.5% of diet for lactating sows and boars to increase water intake and reduce the incidence of urolithiasis.

2.10.3 Other minerals

- Sulphur is also important, with its deficiencies resulting in anorexia, reduced weight gain, decreased milk production, excessive salivation and finally death.
- Selenium is very important and its absorption is enhanced by vitamin E, A and histidine.
- Signs of deficiencies are nutritional muscular dystrophy, retained placenta, poor growth, weakness or premature birth/stillbirth of piglets, depressed immune function, mastitis and metritis

8.11 Activities

Task 1: List all sources of energy, protein, vitamin and mineral in your area

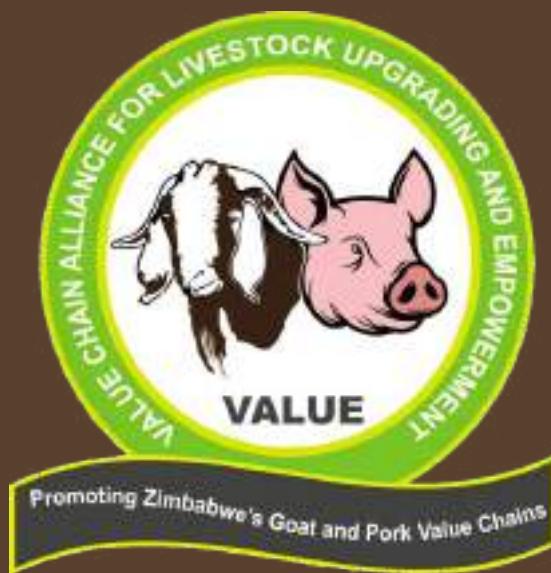
Task 2: Together with the trainer, identify locally available feedstuffs that can be used to provide nutrients to their animals.

Task 3: Together with trainer, identify production bottlenecks that could be as a result of nutrient deficiencies.

Task 4: Get feedback from farmers who have used some of the feedstuff and noted some beneficial outcome.

UNIT
3

Nutrient Requirement and making a complete feed



3. Nutrient requirement and making a complete feed

3.1 Objective

- To classify nutrients and their sources
- To know which body process, require specific nutrient supply
- To introduce learners to methods of blending different ingredients to make a balanced diet for a different class of pigs.

3.2 Outcomes

- Learners should be able to categorise feedstuff into protein, energy, mineral and vitamin sources
- Learners should be able to identify the nutrient requirement for different processes.
- Learners to make their balanced diets using locally available feedstuffs

3.3 Introduction

- No single feedstuff can supply all the nutrients required for all body functions.
- The different feedstuffs must be mixed in proportions to satisfy the requirements for a particular type of pig.
- Feedstuffs from animal sources are better (but expensive) than feedstuffs from plant sources as they have a better balance of nutrients.
- The availability of feedstuffs usually limits production especially in arid and semi-arid areas and certain seasons.

3.4 Feeding standards

- It is a prescription
 - Prescribes the amount of dry matter and the amount and proportion of various digestible nutrients to be fed to a specific animal.
- The quantity of nutrients required by an animal to remain healthy and highly productive
- Are set in accordance with;
 - productivity
 - Milk, meat
 - Composition of the product
 - Fat content in milk
 - Physiological condition
 - Growth, foetal development
- It also differs from animal according to;
 - Breed
 - Age
 - Intended use
 - Consideration is also given to varying regional conditions.
- Are an approximate guide regarding these various requisites of rations
- May be expressed in quantities of nutrients or proportion of the diet
- Quantities of feed an animal requires to remain healthy and highly productive.
- Set in accordance with productivity, the composition of the product, and physiological status.
- Varies with the breed, age, sex, intended use and environmental factors.
- The total animal requirement in feed units such as digestible protein, calcium, P and carotene
- A healthy animal grows quickly; making the best use of the food it is given and will produce good quality meat and produce such as wool and leather for humans to use.
- A sick or suffering animal will not grow quickly so it costs more to maintain.
- It is in farmers' best interests to make sure that the animals in their care are kept healthy throughout their lives.

3.5 Nutrient requirements

- Metabolism is defined as all the chemical and physical processes that take place in the body.
- There are two types of metabolism namely anabolism and catabolism.
- Anabolism is a metabolism that builds tissue
- Catabolism is a metabolism that breaks down materials.

3.6 Body Maintenance requirement

- A condition in which the body is maintained without an increase or decrease in body weight, and with no production or work being done.
- Approximately 50% of feed is used to provide for the maintenance requirement and this must be met before supplying nutrients for other functions.
- Maintenance needs are related to body size hence it can be expressed as $Wt \times 0.75$ metabolic body weight.
- Maintenance energy is required for:
 - Ion transport across cell membranes
 - Body tissues repair
 - Resting muscle activity and the obligatory turnover of tissue protein
 - Control of body temperature,
 - Energy to keep vital organs functioning,
 - Water balance maintenance

3.7 Growth and productivity requirement

- Growth is the increase in protein over its loss in the animal body. It occurs by increases in cell numbers, the cell size, or both.
- Growth requires energy, protein, water, minerals, and vitamins.
- Young animals require more protein to build muscle and grow.
- Monogastric animals also need certain amino acids for proper growth.
- Young animals also need calcium and phosphorus, salt or a normal sodium level, any mineral that may be deficient in the area.
- Iodine and Selenium require special consideration as Iodine deficiency in the foetus prevents thyroxine from being produced, causing goitres and ultimate death in new-borns while Selenium deficiency may cause white muscle disease in new-borns.
- Vitamins are also required by growing animals.
- Vitamins must be supplied to pigs through feeds (usually vitamin D).
- Energy is required to sustain growth, metabolic rate and activities.
- Energy can be supplied by feeding corn, barley or wheat.
- Having satisfied maintenance, additional nutrients are used for productive processes.
- John Hammond introduced the concept of metabolic priorities operating during the time of feed shortages
- It is now accepted that neural tissue has the first call on nutrients, lymphatic and immune system, viscera, bone, muscle and finally fats.
- Foetal development is maintained at the expense of lactation.
- However, during a period of shortage animals use the body reserves to support milk synthesis.

3.8 Fattening requirement

- Before marketing, pigs for the market are primed to fetch a better price and ensure better meat quality.
- The process is done through maximizing the storage of surplus energy from the feed as fat.
- It is a result of excess energy from carbohydrates, fats or protein beyond the maintenance requirements.
- This improves the quality of the carcass at slaughter.

3.9 Reproduction requirement

- Two categories of requirements namely
 - Gamete production and
 - Foetal growth in the uterus.
- Foetus requirements are much greater in the last trimester of pregnancy.
- Nutrition supply to the sow must be adequate during pregnancy.

3.10 Milk production requirement

- Requires considerable protein, minerals, vitamins and energy.
- The need for protein is greater because milk contains more than 3% protein.
- Calcium and phosphorus are the two most important minerals needed for lactation.
- If absent may result in decreased lactation, disease or even death.

Training Manual on Pig Feeds and Feeding

- Energy is the most vital requirement for milk production.
- Nursing sows may need up to four times the energy of a non-lactating sow of the same size.

Table 2: Protein and energy requirements at different production stages

| Pigs | Percent Protein (CP) | Percent Energy (TDN) |
|------------------|----------------------|----------------------|
| Boars | 15 | 85 |
| Dry sow | 12 | 65 |
| Late Gestation | 16 | 85 |
| Lactation | | |
| Sows | 16 | 85 |
| Creep feed | 22 | 85 |
| Weaners | 18 | 85 |
| Growers | 16 | 85 |

3.11 Ration formulation

- It is defined as the use of knowledge about nutrients, feedstuffs, and animals in the development of **nutritionally balanced feed** that will be consumed in **sufficient quantities** to provide the **level of production** desired at a **reasonable cost**.
- Important terms in this definition are:
 - Nutrients composition
 - Feedstuffs
 - Balanced diet
 - Palatability and acceptability
 - Production levels
 - Least-cost but high producing.
- The following information is required from feed analysis for successful ration formulation.
 - Nutritional requirement for different species of animal and preferred feedstuff.
 - The quantities of these specific nutrients in the available feeds.
 - The efficiency of utilisation of available resources
 - Different types of feedstuff
 - Anti-nutritional factors

3.11.1 Principles of formulating rations

- The formulation of feeds at the farm level is very important to the farmer.
- The process reduces the amount of money to be spent on feed.
- Mixing of different ingredients to produce a feed with a balanced nutrient profile to meet a specific demand of a pig at a specific growth stage is vital.
 - Manual and computer-based methods of feed formulation
 - Pearson square method
- For this training, we will focus on the Pearson square method of feed formulation
- Used if there are two ingredients or several ingredients pre-mixed into two components
- It is used to determine the proportions of each of the ingredients in the diet
- Is used as a starting point in the study of feed formulation. You can compute the proper mix of ingredients to attain a certain amount of crude protein (CP).
- Example; If you have corn and soya. (CP of certain ingredients sometimes varies depending on the book you have as a reference.)
- Assuming that maize has 9% CP while soya 44% CP. In a growers ration (pigs) you need a 16% crude protein mix, so, how many parts of maize and soya should be in the mix to attain 16% crude protein.
- The 28 parts are obtained by subtracting 16 CP (protein content of the intended diet) with the CP of the soya which is 44 and the 7 parts are attained by subtracting the 16 CP with the CP of maize which is 9%. 35 is obtained by adding the 28 parts to 7 parts.

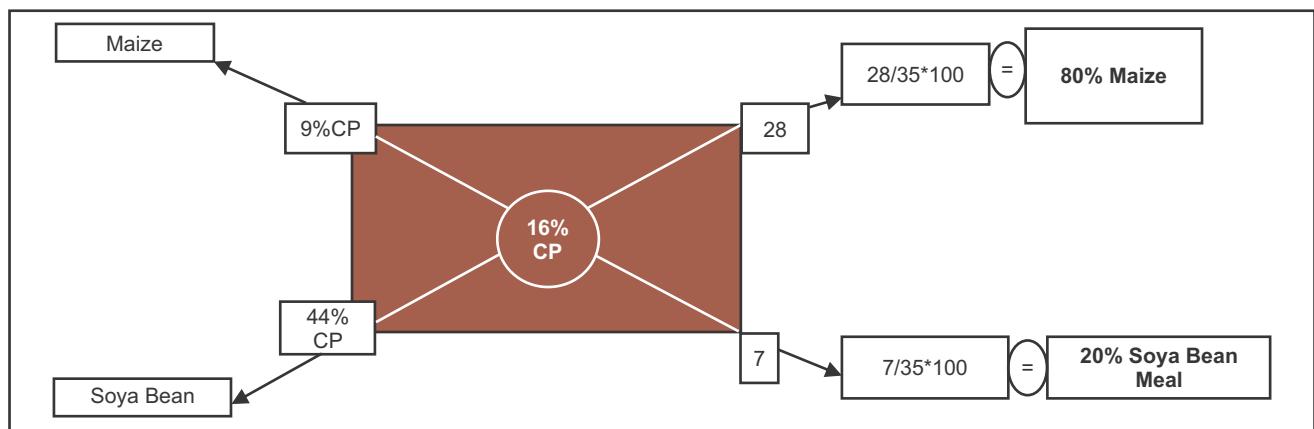


Figure 2: Practical demonstration of the Pearson square method of feed formulation

- Following the formula, we attained 80% parts maize and 20 parts soya. So, if we want 50 kg mixture of maize and soya bean meal with 16% crude protein the composition will be:
 - $50 \text{ kg} \times 80\% = 4000/100 = 40 \text{ kg maize}$.
 - $50 \text{ kg} \times 20\% = 1000/100 = 10 \text{ kg soya cake}$
- **NOTE:** there should be no negative number in the formula. For example, if you use soya with 44 % CP and your target is 16% CP, $16-44 = -28$.
- Drop the negative sign and it should be 28 parts only.
- Note that a modified version of the Pearson square method will have to be used if one is to formulate a complete diet that incorporate fixed percentages of other ingredients like wheat bran and vitamin mineral premixes
- Mineral and vitamin premixes can be bought and added to the feed using the instructions given by the manufacturer.

Table 3: Examples of Feed Formulations for different class of pigs

| Ingredients | Weight class in kg | | | | Breeding herd | |
|--------------------------|--------------------|------------|------------|------------|---------------|------------|
| | 10 -21 | 22 -49 | 50 -79 | 80 -120 | Gestation | Lactation |
| Maize, % | 66 | 74 | 80 | 85 | 86 | 73 |
| Soyabean meal (45% CP) % | 34 | 26 | 20 | 15 | 14 | 27 |
| Dicalcium phosphate, % | 0.01 | 0.007 | 0.006 | 0.004 | 0.16 | 0.013 |
| Limestone, % | 0.009 | 0.009 | 0.008 | 0.008 | 0.009 | 0.01 |
| Salt, % | 0.004 | 0.0035 | 0.0035 | 0.0035 | 0.005 | 0.005 |
| Micro -mineral premix, % | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Vitamin premix, % | 0.055 | 0.005 | 0.005 | 0.005 | .006 | 0.005 |
| Total, % | 100 | 100 | 100 | 100 | 100 | 100 |
| Lysine, % | 1.15 | 0.95 | 0.75 | 0.6 | 0.54 | 0.91 |
| Ca, % | 0.7 | 0.6 | 0.5 | 0.45 | 0.75 | 0.75 |
| P, % | 0.6 | 0.5 | 0.45 | 0.4 | 0.6 | 0.6 |
| ME, kcal/kg | 3308 | 3324 | 3335 | 3343 | 3294 | 3297 |
| Protein, % | 20.8 | 18 | 15 | 13 | 12 | 17 |

3.12 Activity

- ↘ Draw a table listing the common feedstuffs for pigs in your area in the wet and dry season. Include their nutrients contents.
- ↘ Formulate a mixture of maize and soya bean meal with a CP content of 18 CP %.

UNIT

4

FEEDING different classes of pigs



4. Feeding different classes of pigs

4.1 Objective

- To train learners to feed all classes of pigs
- To know which classes of pigs are more vulnerable to nutrient deficiencies
- To introduce learners to methods of feeding pigs.

4.2 Outcomes

- Learners should be able to feed pigs properly
- Learners should be able to identify the effects of feed shortages on production
- Learners to make their balanced diets using locally available feedstuffs

4.3 Feeding under intensive production system

- Figure 10 1 shows how pig production under intensive production system is interlinked.
- Each stage should have its own type of feeds. In the farrowing house, piglets should get good access to colostrum within 6 hours after birth and creep feed.
- Within days after birth, piglets should be introduced to a high-quality high protein diet called creep feed.
- Iron injection of 100mg on day three.
- Creep feed is formulated with skimmed milk and other highly digestible ingredients and should have greater than 22 % crude protein content.
- After weaning, weaners should remain on creep or weaners meal with high crude protein.
- They are moved to the next stage of production after day 56, where they are offered growers meal with about 18 % crude protein content.
- Selected boars and sows are given boar and sow meal with about 15% CP. It should be noted that in pig production there is no one glove fit all in terms of feed types used.

A correct meal for every stage of production is the key to success, no one meal fit all

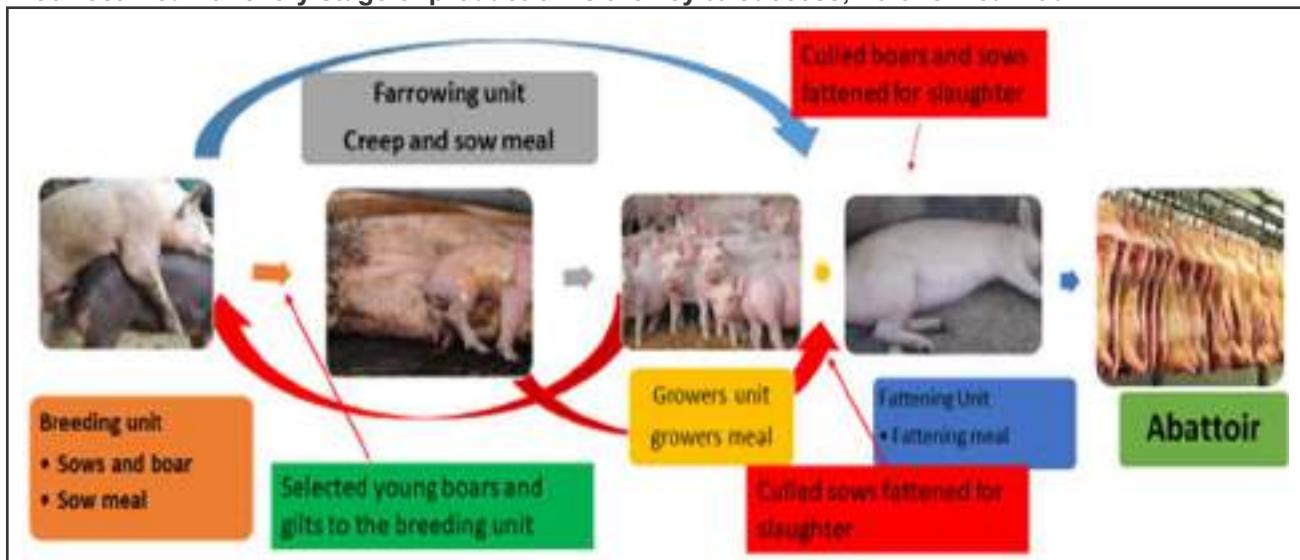


Figure 3: A schematic presentation of a typical pig production unit with all class pigs under different production stages

4.4 What is feeding?

- Offering feed to animals is the process of feeding an animal. Pigs can be fed using total mixed rations or be grazed in properly designed paddocks.
- More than 80% of variable costs in pig production are on feed.
- The most consistent sign of protein deficiency in lactating animals is poor weight gain or slow growth in piglets.
- Protein supplements are oilseed cakes, cowpea, synthetic and animal protein sources.
- It is critical to ensure the provision of all essential amino acids for muscle building and growth.
- Protein should be supplied to meet but not greatly exceed requirements.
- Excess protein supply results in increased feed costs and poor carcass quality.

Table 4-1 shows the feed quantities for pigs.

Table 4: Feed quantities to be offered to pigs

| Type of pig | Quantity of feed per day |
|-----------------|--|
| Lactating sows | $2 + 0.5 \times$ number of piglets being nursed |
| Dry sows | 3 - 4kg |
| Pregnant sow | 2 to 2.3kg |
| Boars | 2.0 to 2.5kg |
| Weaners | $\pm 0.6\text{kg}$ or what piglets consume in 30 minutes |
| Creep | Ad libitum/free of choice |
| Fattening stock | Ad libitum 1.2 to 3kg |

4.5 Aims of feeding pigs?

- Pigs are fed to keep them healthy and to stimulate productivity.
- To achieve greater than 2 farrowings annually, pigs are supposed to be maintained in a good body condition score.
- Body condition score (BCS) is an effective tool for managing both individual animals and the herd.
- A low BCS of an individual animal may be indicative of a disease or poor access to feed as shown in Figure 4-2

| BODY CONDITION SCORING | | | | | |
|---|------------|-------------------------------|--------------------------------|------|-------|
| Image | 1 | 2 | 3 | 4 | 5 |
| Score | 1 | 2 | 3 | 4 | 5 |
| Condition | Emaci-ated | Thin | Ideal | Fat | Obese |
| Detection of Ribs, Back Bone, "H" Bones and Pin Bones | Obvious | Easily detected with pressure | Barely felt with firm pressure | None | None |

Figure 4: A guide to body condition score in pigs

- In a herd, a trend of low BCS may be indicative of inadequate feed quantity, quality or management-related diseases such as internal parasites
- If one records a low BCS in the herd that should be a trigger for investigating management disease or introducing supplementary feeding.
- The majority of high BCS may indicate the need to reduce supplementary feeding.
- Ideally, BCS should be between 2.5 to 3 depending on the animal's stage in the reproductive and production cycle.
- A BCS of 4 for pregnant sow is normal and recommended.
- The whole body to be manually explored and palpated every 3 weeks to determine the BCS of the herd as a management tool.

Table 5: Pig production parameters

| Parameter | Expected performance |
|--------------------------|----------------------|
| Age at puberty (Months) | 5 - 6 |
| Oestrus duration (hours) | 12 - 30 |
| Oestrus cycle (days) | 18 - 23 |
| Gestation (days) | 112 - 118 |
| Average birth weight kg | Breed dependent |
| Large white | 1.5 |
| Landrace | 1.5 |

4.6 Which types of feeds

- Pigs are non-ruminants and should be fed on low fibre diets.
- Protein quality is more important than quantity.
- The most important ingredients for pig feed production are maize and soya cake.
- Pigs can derive nutritional value from numerous feeds.
- However, feeds use is limited by:
 - Digestibility
 - Fat content
 - Palatability
 - Moisture content
 - Anti-nutritional factors

4.6.1 Conventional feeds

- They are feeds that are commercially formulated.
- These are balanced diets specially formulated for a specific group of pigs.
- Conventional feeds can be found in different categories such as creep feed, growers' meal, boar and sow meal
- All these feeds have different protein content levels

4.6.2 Non-conventional feeds

- On-farm formulated or blended feeds using various feed ingredients that are locally available.
- Examples of protein supplements under non-conventional feed are oilseeds such as sunflower seed, cowpea, soya bean and other legume plant seeds.
- It is important to note that most of these have anti-nutritional factors that limit their inclusion level in diets.
- Examples of energy sources are all cereals and cereal by-products.

4.7 Feeding different classes of pigs

- Pigs are most productive when fed a balanced diet according to their nutrient demands.
- Hence feed meant for different classes of pigs (Figure 10 1) should have different energy and protein levels.
- Breeding females have different nutrient requirements as the stage of production changes.
- Maintenance, gestation and lactation are all stages of production with different nutrient requirements, hence meeting these requirements are important for efficient production.
- From a practical standpoint, a body condition scoring should be done every three weeks and a monthly weighing is important.
- Body condition score is an important and cost-effective management tool.
- It guides the farmer as to when to start supplementing and when to reduce supplements.
- The class of pigs to be fed is clearly explained in Figure 10 2.

4.7.1 Boars, Dry sows and Gilts

- The objective is to keep the animal in good body condition i.e. neither too fat nor too thin.
- If they are too thin, increase the amount of feed offered; if too fat the feed should be reduced.
- Give the boar 2.0-2.5kg, gilt and dry sow 3-4kg, pregnant sow 2-2.3kg of dry sow feed.
- You increase the supply in cold weather.
- Divide the feed into two equal parts, one for the morning and the other for the afternoon (Figure below).
- Water requirements range from 10 - 20 litres per day depending on size and weather.
- Fresh water should be supplied at all times.

- If a diet is inadequate in any essential amino acid, protein synthesis cannot proceed beyond the rate at which that amino acid is available.
- Deficiency of one or more amino acids will result in depressed growth rate, poor feed conversion or reduced reproductive performance.
- Therefore, protein quality can be defined as how closely the essential amino acids in the protein source come to meeting the pig's estimated requirement for those amino acids.
- The 10 essential amino acids that must be provided in swine diets are lysine, threonine, tryptophan, methionine (and cystine), isoleucine, histidine, valine, arginine, and phenylalanine (and tyrosine).
- Most cereal grains are limiting in lysine, tryptophan, and threonine.
- Therefore, when evaluating feed ingredients, these amino acids, especially lysine, are most important in determining protein quality.

4.7.2 Practical management before breeding

- Increase feed allowance to maximize the number of eggs released. This is referred to as flushing.
- Flushing involves increasing nutrition, particularly energy just before and during the early breeding season.
- The process increases the ovulation rate thus litter size.

4.7.3 Feeding during pregnancy

- For the first two and half months of pregnancy, the daily allowance for the sow is the same as the dry animals.
- In the last month, feed intake should be increased gradually by 0.25 kg in the 11th week of pregnancy through to 0.75 kg in the last week of pregnancy. This is called Steaming up.
- However, do not overfeed because over fat sows tend to have problems at farrowing.
- One day before farrowing, reduce the feed by half to avoid constipation.
- Use the sow gestation table to calculate 'steaming up period'.

4.7.4 Lactating Sow and Her Piglets

- The amount of feed given to the sow depends on the number of piglets in the litter.
- Give basic allowance of 2 kg of sow meal.
- In addition to the 2 kg, give 0.5 kg of the feed for every piglet in her litter.
- For example, if her ration is 2 kg and she has 10 piglets in her litter, her daily allowance will be $2 + (10 \times 0.5) = 7$ kg per day.
- Feed in two equal meals; one in the morning and the other in the afternoon.
- Inject piglets with iron on the third day.
- Provide creep feed 22% CP to the piglets 7 days after birth (if justified by the price for piglets).
- Pig creep feed should be fed ad lib from day 7 to day 56 after which piglets are moved to pig grower meal.

4.7.5 Management of piglet

- Ensure that each piglet has access to a teat to take colostrum within 6 hours of birth. Colostrum contains antibodies that give piglets immunity. This is very essential for piglet survival.
- Iron is required for normal blood formation and transportation of oxygen.
- Piglets need iron supplementation to prevent anaemia (Piglet anaemia).
- Iron can be supplied from several sources:
 - Place clods of red soil in the pen. Take care to get soil from an area that is not contaminated with worms.
 - Buy iron tablets and give them to the piglets. Caution: piglets can cough them out.
 - The iron solution can be provided by rubbing it on the sow's teats.
 - Use iron injections. An experienced person should administer the injection.

4.7.6 Growing and finishing stages

- Piglets should weigh between 12 and 21 kg on day 56 as shown in Figure 10.3.
- Weaners may continue with creep feed for 3-4 more weeks after weaning.
- Pig grower's meal 18% fed from 8 weeks to 16 weeks
- Pig finisher meal (16%CP) from 16 weeks until slaughter
- The growing stage is defined as the stage from weaning up to 60kg live weight.
- The aim is to maximize lean muscle production and minimize fat deposition.
- The amount of feed will depend on the body weight of the pig.
- Since growing animals are kept in groups the daily feed is obtained by multiplying the feed per pig by the number of animals in a pen.

Training Manual on Pig Feeds and Feeding

Table 6: Summary of age, body weight, feed amount requires and type of feed

| Age of pig (weeks) | Weight (KG) | Daily gain (grams) | Feed consumption Per day (Kg) | Water consumption per day (Litres) |
|--------------------|-------------|--------------------|-------------------------------|------------------------------------|
| 4 | 7 | 210 | 0.35 | 0.9 |
| 6 | 12 | 400 | 0.75 | 1.9 |
| 8 | 21 | 625 | 1.0 | 2.5 |
| 10 | 30 | 655 | 1.2 | 3.0 |
| 12 | 40 | 710 | 1.4 | 3.6 |
| 14 | 51 | 805 | 1.7 | 4.2 |
| 16 | 65 | 970 | 1.9 | 4.8 |
| 18 | 80 | 1020 | 2.2 | 5.5 |
| 20 | 95 | 1120 | 2.4 | 6.0 |
| 22 | 110 | 1100 | 2.65 | 6.6 |

(Source: <https://www.agrifarming.in/pig-feed-chart-and-pig-weight-chart-for-beginners>)

4.8 Activity

- ↳ **Task 1:** Participant to discuss how they feed their piglet, weaners, dry sows, boars and lactating sows.
- ↳ **Task 2:** Participant to identify challenges they face in feeding their pigs.

UNIT
5

Marginal feeds



5. Marginal feeds

5.1 Objective

1. To train learners on methods of reducing feed cost
2. To educate farmers on other feed resources and alternative feeding methods
3. To introduce learners to methods of feed processing.

5.2 Outcomes

1. Learners should be able to feed pigs properly.
2. Learners should be able to identify the effects of feed shortages on production
3. Learners to make their balanced diets using locally available feedstuffs

5.2.1 Integrating Pig Production

- Offers the possibility of reducing the costs of buying protein supplements.
- Crops
 - Crops grown for human food can be used as pig feed
 - Feed cull sweet potatoes, bananas, yams, cassava and their peels
 - Cook to destroy toxic substances and improve digestibility
 - Supplement them with a good quality protein source like soybean or fish
 - Peels and roots should be dried before feeding if possible

5.2.2 Use of left-over food from kitchens

- Some farmers have access to left-over food from schools, hospitals and hotels.
- For safety left over food should only be fed after boiling for at least 30 minutes.
- To improve performance, feed a limited quantity of complete meal in addition to the kitchen leftovers.

5.2.3 Pasture/Forage Feeding

- If properly maintained pasture/forage can be a good source of nutrients for pigs.
- The forages can be harvested, or pigs may be allowed to graze.
- Pigs however grow slowly and may get heavy worm infestation.
- It is therefore better suited for mature breeding animals.
- The forage should be young.
- Reduce the level of complete feed given by 1 kg
- Rotate the animals on pasture. Provide shelter in the pasture or plant many trees in the grazing field.

5.3 Mycotoxins

- Mycotoxins are toxic substances produced by moulds and fungi on plants, on the field or during the storage.
- Pigs are considered highly susceptible to mycotoxin contamination, with young animals and female breeders being the most sensitive groups.
- Mycotoxins can cause clinical symptoms or subclinical symptoms decreasing animal performance leading to great economic losses shown in figure 11.1.
- Symptoms vary considerably depending on which mycotoxin is responsible and can range from fertility and reproductive problems, reduced productivity, suppressed immunity and various pathological effects on organs and tissues.

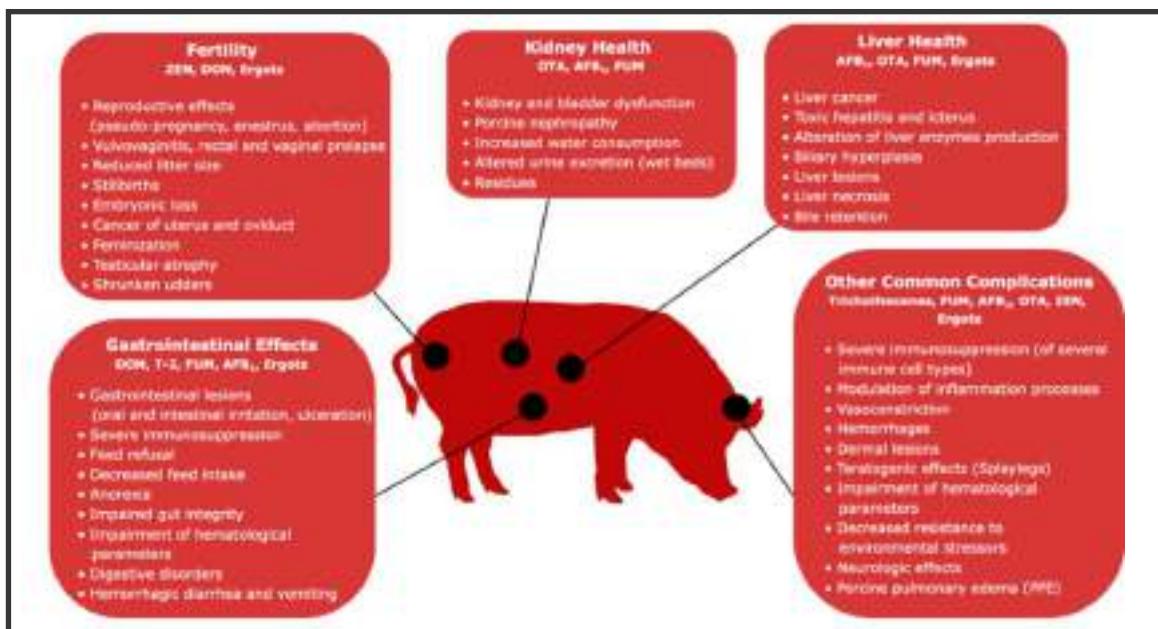


Figure 5: Effect of mycotoxins in pigs (Source: <https://www.biomin.net/species/pigs/mycotoxins/>)

- Feeds must not be stored for too long and the principles of first in first out (FIFO) should be adhered to religiously.
- Grain moisture levels of 22-26% provide ideal conditions for mycotoxins production hence it is important to make sure feed has the correct dry matter levels.
- A few example are hereby given but there are many mycotoxins

Zearalenone in Maize

- Zearalenone contamination of cereals (particularly maize) often occurs in warm and humid conditions
- Zearalenone is an oestrogenic toxin (i.e. it mimics the action of the hormone) and therefore adversely affects reproductive function.
- Clinical signs of zearalenone toxicity include rectal and vaginal prolapses in sows. Nursery and grow finish pigs may exhibit reddening of the vulva and swelling.
- Irregular oestrus cycles and reduced litter sizes are also commonly observed.
- Ergot toxins, especially on Pearl millet/ mhunga/maize causing Agalactia
- Ergot toxins occur in grains by entering into the seed and developing into a dark elongated body called a sclerotum.
- This contains toxic alkaloids, such as ergometrine.
- This reduces the size of blood vessels and restricts the blood supply, particularly to the mammary gland and body extremities.
- Levels above 1g of sclerotum per kg of feed produce clinical signs of ergot poisoning.
- Additionally, Ergot toxins can impact the secretion of Prolactin, particularly at parturition, which can lead to Agalactia.
- Typical signs of ergot poisoning include poor growth rates, rapid breathing and general depression.
- New-born piglets are small and weak with a low survival rate. Milk production in lactating sows may be depressed.
- Lameness may also be evident due to necrosis and sloughing of hooves.
- Tail and ear necrosis is also common, which eventually leads to gangrene.

5.4 Feed wastage

- Having waste of any kind implies that there is inefficiency, and wasting feed is a very costly inefficiency.
- Minimizing feed waste makes good business sense, and in many cases, it can be accomplished with minor changes in management practices.
- Feed is wasted along the entire feed line from field to rectum!
- It is estimated that 10% of feed delivered is wasted on the average farm.

- Use the right feed at the right time:
 - It is essential that pigs progressively move to the cheaper diets as soon as possible, while maximizing their growth potential.
 - Keeping pigs on the expensive early diets for longer than warranted, increases costs.
 - On several farms, the pigs are kept on expensive weaners diets too long to compensate for the poor feed intake and growth in the first week post-weaning.
- Use correct feed
 - It is essential to adopt a suitable diet.
 - In times of high prices, it is tempting to simplify and cheapen the feed, but growth and health could be affected.
 - Note if the pig's growth slows down, this cannot be allowed to affect pig flow and all-in/all-out systems.
 - Poorly formulated diets are more likely to result in diarrhoea, resulting in raw feed ingredients ending up on the floor.
- Feed preparation
 - Feed which is incorrectly prepared - ground or rolled, can result in increased waste.
 - Whole grains cannot be digested by the pig and are passed out whole and undigested - and are therefore wasted
 - Ingredients with anti-nutritional factors reduce efficiency of use and increase feed wastage
- Feed available when pigs enter a house
 - It is essential that pigs are fed the correct diet immediately when they enter the house.
 - Requiring the pigs to eat up the last of the previous group of pigs' feed is not acceptable.
 - Such feed may contain the incorrect ingredients or medications, or if it has been left for more than a couple of days, has become soiled with moulds, rodent faeces or urine.

5.5 Feed records

- Feed usage is the largest cost centre, and the monitoring of costs per tonne, costs of live weight gain and efficiency of use are vital.
- It is here that the greatest use of records and if possible computer technology can be made.
- Records of all ingredients and feeds used should be available.

5.6 Activity

- ↘ **Task 1:** Participants to identify other projects they can do together with pig production in order to lower feed cost.
- ↘ **Task 2:** Participants to identify other nearby enterprises producing by-products which can be used to minimize feed costs.
- ↘ **Task 3:** Discuss presence of mycotoxins in pig feeds or ingredients
- ↘ **Task 4:** List all benefits that can be derived from alternative feeding strategies and integrated pig production system.

6. References

1. AfrII 2016 Piggery Production Manual: How to Rear Pigs using The Deep Litter System (DLS) or Fermented Bed Technology (FBT). Africa Innovations Institute, Kampala, 54pp.
2. FAO. A Handbook for Farmers. 2066. Food and Agriculture Organization of the United Nations, Emergency Rehabilitation and Coordination Unit
3. Farmer's Hand Book on Pig Production (For the small holders at village level). 2009. Food and Agriculture Organization of the United Nations. GCP/NEP/065/EC. Terme di Caracalla, 00153 Rome, Italy
4. <https://www.agrifarming.in/pig-feed-chart-and-pig-weight-chart-for-beginners> accessed on 18 December 2020
5. <https://www.biomin.net/species/pigs/mycotoxins/> accessed on 18 December 2020
6. <https://www.purinamills.com/swine-feed/education/detail/how-to-creep-feed-pigs-for-best-results> accessed on 10 October 2020
7. <https://www.thepigsite.com/articles/how-to-farm-pigs-feeding> accessed on 10/10/2020
8. Nantima, Noelina & Ocaido, Michael & Davies, Jocelyn & Dione, Michel & Okoth, Edward & Mugisha, Anthony & Bishop, Richard. (2015). Characteristics of smallholder pig production systems in four districts along the Uganda-Kenya border. Livestock Research for Rural Development. 27.

This publication has been produced with the financial support of the European Union. Its contents are the sole responsibility of the VALUE project and does not necessarily reflect the views of the European Union.

