



GEAVET TRAINING PROGRAMME FOR CSA

LIVESTOCK SMART SKILLS AND CLIMATE-SMART POST-HARVEST PROCESSING:

UGANDA

UNIT 1.3 FEED MANAGEMENT

ENGLISH VERSION

GEAVET Project n° 101129027



Open Educational Resources



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PART I – LEARNING MATERIAL

1. Introduction

This curriculum provides a practical, skills-based introduction to animal nutrition, feed management, and modern livestock feeding practices, designed specifically for trainees working in Uganda and similar smallholder livestock systems. It combines essential nutrition foundations with hands-on activities to help farmers and VET learners improve animal performance, reduce feed costs, and use local resources more efficiently. This training covers key topics such as nutrient requirements, local Ugandan feed resources, feed processing and storage, feed conversion ratios (FCR), and production efficiency. Special attention is given to common challenges in Uganda—seasonal feed shortages, declining forage quality during the dry season, limited access to commercial concentrates, and the need for affordable, sustainable feeding strategies.

The curriculum also introduces Precision Feeding and Precision Livestock Farming (PLF) concepts, showing how simple tools (like mobile phones, observation checklists, or basic digital applications) can support better grazing management, early detection of health problems, and more efficient use of limited feed resources, even where technology access is low. By the end of the training, participants will be equipped to make informed, sustainable feeding decisions that improve productivity and resilience in Uganda’s livestock sector.

2. Basics of Animal Nutrition

Animal nutrition forms the cornerstone of effective livestock management. Understanding how animals utilize nutrients is crucial for improving productivity and maintaining health.

Key nutrient categories include:

- **Proteins:** Essential for growth, tissue repair, and milk/meat/egg production. Protein quality and digestibility vary across feed sources such as soybean meal, cottonseed cake, and fishmeal.
- **Carbohydrates:** The main source of energy for maintenance, activity, and production. Common energy feeds include maize, cassava, and sorghum.
- **Fats and Oils:** Concentrated sources of energy that also enhance feed palatability and absorption of fat-soluble vitamins.
- **Vitamins and Minerals:** Vital micronutrients that support immunity, reproduction, and bone development. Deficiencies can lead to metabolic disorders and reduced productivity.
- **Water:** Often overlooked but critical for all physiological functions including digestion, thermoregulation, and waste elimination.

3. Feed types: roughages, concentrates, supplements

Animal feed can be classified into three primary types: roughages, concentrates, and supplements. Each category serves a distinct purpose in livestock nutrition and has unique characteristics that influence growth, reproduction, and overall animal health.

3.1. Roughages

Roughages are high-fiber feeds that primarily consist of plant materials such as grass, legumes, and other forbs. They are characterized by their strong structural components, which provide essential dietary fiber critical for ruminant digestion. Various roughage species can enhance forage intake and weight gain in ewes, particularly when a preferred mix of roughage is available, demonstrating the importance of quality and type in maximizing feed efficiency. Additionally, roughages help stimulate rumen function and promote the growth of beneficial rumen microorganisms, thereby improving overall digestion and nutrient absorption.

Examples of roughages include grass hay, silage, straw, and fresh forages. These materials are vital in the diets of herbivorous animals, especially ruminants, as they fulfill their requirements for energetic and fibrous components integral to their digestive processes.

3.2. Concentrates

Concentrates are feeds that are high in energy, low in fiber, and rich in nutrients such as carbohydrates and proteins. They are typically derived from grains, legumes, and by-products of various processing industries. Concentrates serve to supplement the nutritional deficiencies found in roughages and can significantly enhance weight gain and productivity when included in animal diets.

Concentrates can further be divided into protein-rich sources such as soybean meal and fishmeal, and energy sources like corn and barley. Research conducted has confirmed that the appropriate use of concentrates can optimize milk production and growth rates in dairy cattle, showcasing the importance of balancing roughages and concentrates in diets. The careful formulation of these diets, especially during periods of high energy demand, can significantly affect overall animal performance.

3.3. Supplements

Supplements are additional feed components included in rations to provide vital nutrients that may be lacking in the primary feed sources. They can include vitamins, minerals, omega fatty acids, and various additives designed to

enhance digestion and overall metabolic functions. For instance, mineral and vitamin supplements are essential in promoting bone health and reproductive success in animals, while protein supplements can improve muscle development and milk yield.

The role of supplements in animal nutrition is crucial, particularly in modern livestock management, where the appropriate enhancement of feed quality and nutrient density is necessary to ensure optimal growth and productivity under varying environmental conditions. Supplements can also modify the fatty acid composition of milk, indicating their potential to influence product quality as well as animal health.

4. Feed conversion ratios and production efficiency

Feed conversion ratios (FCR) and production efficiency are critical metrics in animal husbandry, playing a fundamental role in evaluating how effectively livestock convert feed into body mass or product yield, such as milk and eggs. Understanding these concepts is essential for optimizing production practices and enhancing sustainability within the agricultural sector.

Feed Conversion Ratio (FCR)

The feed conversion ratio is a quantifiable measure reflecting the efficiency with which animals convert feed into desired outputs (e.g., weight gain, milk production). It is calculated by dividing the total quantity of feed consumed by the total weight gain over a specific time period. For example, if a chicken consumes 2 kg of feed to gain 1 kg of weight, the FCR would be 2:1, indicating that it takes 2 kg of feed to produce 1 kg of live weight.

Formula:

$$FCR = \frac{\text{Mass of feed input}}{\text{Mass of output (weight gain)}}$$

$$FCR = \text{Mass of feed input} / \text{Mass of output (weight gain)}$$

FCR serves not only as an economic indicator but also as a predictor of overall production efficiency across species. In broiler chickens, selective breeding for lower FCR values has resulted in substantial gains in productivity over the years. Furthermore, identifying genetic determinants of FCR has been shown to improve feed efficiency, thereby lowering production costs associated with feed, which is often the largest expense in animal production systems.

4.1. Production Efficiency

Production efficiency concerns how well animals utilize the energy and nutrients from their feed. It is often assessed through metrics like the residual

feed intake (RFI), which reflects the difference between actual feed intake and expected intake based on metabolic body weight and growth rates. High production efficiency indicates that animals use less feed to achieve similar or greater output compared to their contemporaries.

Improvements in FCR and overall production efficiency are essential for sustainability. The agricultural sector faces pressure to reduce resource consumption and environmental impact while meeting the growing global demand for animal products. For example, optimizing feed conversion can substantially lower greenhouse gas emissions associated with livestock farming. Efficient use of feed not only conserves resources but also promotes animal welfare by mitigating the environmental footprint of livestock operations.

4.2. Factors Influencing FCR and Production Efficiency

Genetics: Selective breeding can enhance traits related to feed efficiency, as seen in turkeys and pigs where targeted breeding has improved FCR and RFI significantly.

Nutrition: The quality of feed and its digestibility directly affect FCR and overall nutrient absorption in livestock. Feed formulations that include high-quality ingredients or specific additives can improve efficiency. For instance, probiotic supplementation has shown positive results in enhancing feed efficiency and performance in poultry.

Management Practices: Proper management, including optimizing feeding strategies and housing conditions, can influence feed intake and conversion efficiency. For example, high-density living conditions and dietary mismanagement can lead to increased competition for feed, reducing overall efficiency.

Health: The health status of livestock also impacts feed efficiency, as healthier animals typically exhibit better growth rates and lower feed consumption per unit of gain.

5. Precision Feeding: An Overview

Precision feeding involves the careful tailoring of diets to better match the individual nutritional requirements of animals rather than using a one-size-fits-all approach. This practice requires real-time assessment of the nutritional potential of feed ingredients and precise determination of each animal's daily nutrient requirements. This equates to providing the right type and quantity of feed at the right time to meet individual needs, thus improving performance outcomes in growth and milk production, as seen in various livestock.

Precision feeding is about getting the right nutrient to the right animal at the right time. Although direct mitigation effects are uncertain and hard to predict, precision feeding will increase feed efficiency and productivity and consequently can improve farm profitability. This can be done by controlling individual feed intake, the amount and composition of manure produced and the associated emissions from manure and the enteric CH₄ production. Moreover, feed efficiency was identified as one of the most important parameters controlling GHG-emissions intensity.

The implementation of precision feeding systems has been particularly effective in livestock production. For example, Pomar and Remus (2022) state that precision feeding can significantly reduce nitrogen excretion by approximately 30%, thus contributing to more sustainable agricultural practices, which is essential for minimizing waste and alleviating environmental pressure caused by livestock farming.

What is precision Feeding:

https://youtu.be/jdm7h9vR_3Y

Demonstration Farm of IFIP: The French Technical Institute for PIGS:

https://youtube/TvbZA_fb49Q

5.1. Technological Integration in Precision Nutrition

The development of precision feeding systems has been greatly enhanced by advancements in technology. Automated monitoring systems and sensors now enable farmers to adjust feeding strategies dynamically based on individual animal behavior and performance (Akintan et al., 2024). This capability is fundamental for optimizing production efficiency and minimizing resource consumption.

One of the most notable advancements is the adoption of precision livestock farming (PLF) tools that utilize data from feed intake and animal behavior. These systems are designed to optimize feed efficiency while minimizing waste, which ultimately contributes to reducing greenhouse gas emissions associated with livestock feeding and feed production. They enable a farmer to monitor animals automatically and to create added value by helping to secure improved health, welfare, yields and environmental impact.

Examples of PLF technologies include: Sensor placement robot for pigs, intelligent ventilation control in livestock buildings, cattle monitoring system, improved thermal control for pigs via machine vision, improving profitability via precision feeding for pigs.

AI algorithms are increasingly utilized to analyze vast amounts of data, facilitating the creation of individualized feeding programs tailored to the specific nutritional needs of animals. This personalization enhances animal

growth and health outcomes by ensuring that nutritional deficiencies are addressed.

Moreover, IoT technology has further propelled innovations in feed management by enabling real-time monitoring and automation. Internet of Things (IoT) devices can collect and transmit data regarding environmental conditions such as temperature and humidity, which are critical for maintaining optimal feeding conditions. This continuous monitoring allows farmers to make data-driven decisions to adjust feed and manage animal health proactively. For instance, automated feeding systems equipped with sensors can dispense feed based on consumption patterns, improving feed utilization and reducing waste.

5.2. Nutrient Efficiency and Sustainability

The benefits of precision feeding extend beyond individual animal performance; they contribute significantly to overall sustainability within livestock systems. Techniques that incorporate precision nutrition are designed to reduce the environmental impact of animal agriculture while enhancing financial viability. Modeling nutrient requirements can improve performance across various climates, which is essential in the face of global supply challenges.

Moreover, employing individualized feeding regimens rather than traditional phase-feeding approaches enables livestock producers to maximize nutrient utilization. For example, research indicates that precision feeding can reduce lysine intake and nitrogen excretion without compromising growth in pigs, thereby representing a sustainable option in managing feed resources.

Prabakar et al. (2024) note that advancements in nutritional science and precision feeding allow for diets to be formulated that account for individual variations in growth rates, health status, and production goals.

In addition, the exploration of alternative protein sources, such as insects, algae, and by-products from various industries, has gained significant traction in animal nutrition. Insects, particularly black soldier fly larvae (*Hermetia illucens*), are being recognized for their nutritional benefits and sustainability potential. Star et al. (2020) demonstrated that incorporating live black soldier fly larvae into the diets of laying hens improved production performance and egg quality, thus addressing welfare concerns in poultry farming. Similarly, Ghanima et al. (2020) has shown that essential oils derived from herbs like rosemary and cinnamon significantly enhance performance and health parameters in layers, suggesting that integrating plant-based alternatives alongside insect proteins can optimize diet quality.

Fu et al. (2024) further highlight that insects represent a sustainable feed source capable of reducing the environmental footprint of livestock production. Other innovative protein sources being studied include algae and single-cell proteins, which have shown promise in aquaculture and poultry systems, exhibiting potential benefits for nutrient density and environmental sustainability.

Further, feed additives such as enzymes, probiotics, and organic acids have become increasingly important in improving gut health and nutrient absorption in livestock.

Moreover, the use of essential oils is being explored as an alternative to traditional antibiotic growth promoters. Essential oils can enhance nutrient digestibility and inhibit harmful microbial growth, thus improving livestock production efficiency while promoting gut health. These feed additives not only support the animal's immune system but also mitigate adverse environmental effects associated with antibiotic use, making them invaluable in modern feed management.

6. Local Feed Resources and Formulation Techniques in Uganda

In Uganda, the utilization of locally available feed ingredients is essential for improving livestock nutrition and enhancing the sustainability of animal production systems. Recent research has focused on several innovative and accessible feed sources, particularly emphasizing alternative proteins, by-products, and traditional feeds.

6.1. Alternative Protein Sources

One of the most promising developments in Uganda's feed management is the use of insects as alternative protein sources. The Black Soldier Fly (*Hermetia illucens*) larvae have emerged as a significant feed ingredient due to their high protein content and favorable amino acid profile. Bbosa et al., (2019) found that insects such as the Black Soldier Fly provide substantial amounts of protein and amino acids, making them a viable alternative to traditional protein sources like fish meal and soybean meal. This insect is not only sustainable but also highly efficient in converting organic waste into protein, thus providing an ecological solution for livestock feed in Uganda.

6.2. By-products and Local Feeds

In Uganda, various agricultural by-products are also utilized as crucial feed ingredients. Common by-products include maize bran, rice bran, and sweet potato vines, which serve as low-cost sources of energy and nutrients for livestock. These by-products, when properly processed, can enhance the

nutritional quality of animal diets, as their utilization in livestock feeding is well-documented.

Furthermore, the use of green forages is prevalent in Uganda's pastoral systems due to their role in providing year-round feed and improving livestock productivity. Farmers cultivate improved forages like Napier grass (*Pennisetum purpureum*) to meet feed gaps, especially during dry seasons, with adoption influenced by factors like yield potential and farmer characteristics such as age, land ownership, and education.

Video about nutritious varieties of grass:

<https://youtu.be/y6RHEFkQmQM?t=8>

Benefits of green forages:

- **Supplements natural pastures:** They provide a more consistent and nutritious food source than often degraded natural pastures, which are frequently deficient and become dry during the dry season.
- **Increases livestock productivity:** Integrating improved forages can increase milk yields, dry matter intake, and manure production.
- **Improves soil health:** When integrated with crop systems, forages can improve soil organic carbon and reduce soil loss

Popular forage types:

- **Napier grass:** This is the most widely cultivated improved forage in Uganda
- **Rhodes grass:** This gives a high return for farmers in extensive systems
- **Brachiaria:** This is also common in Uganda, particularly naturalized *Brachiaria* species.

7. Feed Production, Processing, and Storage

7.1. Feed Processing Methods

Feed processing methods, such as pelleting, grinding, and drying, are essential for optimizing the digestibility and acceptability of animal feeds. Pelleting, a common method for compacting feed, increases nutritional efficiency and decreases feed wastage. Studies indicate that pelleted feeds can improve weight gain and feed conversion rates in livestock, particularly in poultry and swine, as they enhance feed accessibility and palatability. Grinding, another critical processing step, involves size reduction of raw ingredients, which increases surface area for digestive enzymes and facilitates better nutrient absorption. Different grinding techniques, such as hammer and roller milling, affect energy consumption and pellet quality, with coarser grinding suggested

to improve certain classifications of poultry feed due to better digestive efficiency.

Drying processes, often employed in the preparation of silage and hay, minimize moisture content, which is crucial for preventing fungal growth and mycotoxins. Proper drying techniques maintain high nutritional standards while preserving feed quality during storage. The incorporation of thermal treatments during feed processing can also significantly reduce microbial contamination risks, reinforcing the importance of using proper temperature controls during production.

7.2. Silage and Hay Making

The production of silage and hay involves specific preservation techniques to ensure the nutritional value of the forage is maintained over time. Silage is produced by the anaerobic fermentation of crops like corn or grass, which helps preserve nutrients and prevent spoilage. During silage production, maintaining optimal moisture levels is vital for most crops (around 60-70%); too high moisture can lead to undesirable fermentation and spoilage while too low moisture can impede fermentation, leading to loss of nutritional quality.

Hay making, while traditionally a method of sun-drying crops, has seen innovations to better preserve quality. Effective harvesting techniques, which consider timing and moisture content, can significantly influence the quality of hay, reducing the risk of mold and toxicity. Both processes require careful monitoring to reduce spoilage and ensure high feed quality.

7.3. Feed Storage and Handling

Proper storage and handling practices are critical in preventing contamination of feeds, particularly with pathogens such as *Salmonella*, which can be transmitted from raw materials into finished feeds. Studies have shown that maintaining clean storage facilities and regularly monitoring for contamination are effective measures. Additionally, implementing good manufacturing practices (GMP) within feed production facilities can prevent cross-contamination during processing.

It is essential to manage the storage environment when keeping feed, including controlling humidity and temperature, as these factors significantly impact mold growth and mycotoxin production. For example, both moisture content and temperature fluctuations can lead to accelerated degradation of nutrient quality and increased contamination risk. Regular assessments of feed quality using tests for mycotoxins and molds can be incorporated into routine quality management systems to mitigate these risks.

8. References

- Akintan, O., Gebremedhin, K. G., & Uyeh, D. D. (2024). Animal feed formulation—connecting technologies to build a resilient and sustainable system. *Animals*, *14*(10), 1497. <https://doi.org/10.3390/ani14101497>
- Andretta, I., Pomar, C., Rivest, J., Pomar, J., & Radünz, J. (2016). Precision feeding can significantly reduce lysine intake and nitrogen excretion without compromising the performance of growing pigs. *Animal*, *10*(7), 1137–1147. <https://doi.org/10.1017/s1751731115003067>
- Basarab, J. A., Beauchemin, K. A., Baron, V. S., Ominski, K., Guan, L., Miller, S. P., ... & Crowley, J. J. (2013). Reducing GHG emissions through genetic improvement for feed efficiency: Effects on economically important traits and enteric methane production. *Animal*, *7*, 303–315. <https://doi.org/10.1017/s1751731113000888>
- Bbosa, T., Ndagire, C. T., Mukisa, I. M., Fiaboe, K. K. M., & Nakimbugwe, D. (2019). Nutritional characteristics of selected insects in Uganda for use as alternative protein sources in food and feed. *Journal of Insect Science*, *19*(6). <https://doi.org/10.1093/jisesa/iez124>
- D, T. E., Ayele, M., Waktole, H., Tamir, B., Regassa, F., & Tufa, T. B. (2023). Effects of phytogenic feed additives on body weight gain and gut bacterial load in broiler chickens. *World's Veterinary Journal*, *13*, 205–213. <https://doi.org/10.54203/scil.2023.wvj22>
- De Heus Animal Nutrition. (n.d.). *Tailored roughage management – For dairy cows*. <https://www.deheus.com/animal-nutrition/feed-types/roughage-management#:~:text=Roughage%20has%20a%20very%20positive%20impact%20on,protein%20and%20energy%20source%20in%20most%20countries>
- El-Hack, M. E. A., Allam, A. A., Aldhalmi, A. K., Kamal, M., Arif, M., Alawam, A. S., ... & Ashour, E. A. (2025). Integrating metabolomics for precision nutrition in poultry: Optimizing growth, feed efficiency, and health. *Frontiers in Veterinary Science*, *12*. <https://doi.org/10.3389/fvets.2025.1594749>
- Fu, C., Cheema, W. A., Mobashar, M., Shah, A. A., & Alqahtani, M. M. (2024). Insects as sustainable feed: Enhancing animal nutrition and reducing livestock environmental impression. *Journal of Animal Physiology and Animal Nutrition*, *109*(2), 280–290. <https://doi.org/10.1111/jpn.14055>
- Gasco, L., Stejskal, V., Tran, H. Q., Costantini, M., Zoli, M., Bacenetti, J., ... & Gai, F. (2025). Use of protein from black soldier flies in fish feed. *Burleigh Dodds Series in Agricultural Science*, 105–146. <https://doi.org/10.19103/as.2024.0139.06>

- Ghanima, M. M. A., Elsadek, M. F., Taha, A. E., El-Hack, M. E. A., Alagawany, M., Ahmed, B. M., ... & El-Sabrou, K. (2020). Effect of housing system and rosemary and cinnamon essential oils on layers performance, egg quality, haematological traits, blood chemistry, immunity, and antioxidant. *Animals*, 10(2), 245. <https://doi.org/10.3390/ani10020245>
- Guo, Q., Huang, L., Jiang, Y., Wang, Z., Bi, Y., Chen, G., ... & Chang, G. (2022). Genome-wide association study of feed efficiency related traits in ducks. *Animals*, 12(12), 1532. <https://doi.org/10.3390/ani12121532>
- Lao, E. J. (2021). Scrutinizing the opportunities, challenges and sustainability of brewers' spent grain as a feed source for dairy cattle. *Big Data in Agriculture*, 3(2), 56–64. <https://doi.org/10.26480/bda.02.2021.56.64>
- Malomo, G. A., & Ihegwuagu, N. E. (2017). Some aspects of animal feed sampling and analysis. *Ideas and Applications Toward Sample Preparation for Food and Beverage Analysis*. <https://doi.org/10.5772/intechopen.70856>
- Mapato, C., & Wanapat, M. (2018). New roughage source of Pennisetum purpureum cv. Mahasarakham utilization for ruminants feeding under global climate change. *Asian-Australasian Journal of Animal Sciences*, 31(12), 1890–1896. <https://doi.org/10.5713/ajas.18.0210>
- Pomar, C., & Remus, A. (2022). 242 The impact of feed formulation and feeding methods on pig and poultry production on the environment. *Journal of Animal Science*, 100(Supplement_3), 124–124. <https://doi.org/10.1093/jas/skac247.237>
- Prabakar, G., Arun, L., Kumaravel, P., Chahande, J. M., Majumder, J., Gangopadhyay, S., Biswas, S., Ganai, I. A., & Deka, I. (2024). *Advancements in Animal Nutrition an Insights from Veterinary Science*. *Uttar Pradesh Journal of Zoology*, 45(16), 139–145. <https://doi.org/10.56557/upjoz/2024/v45i164294>
- Star, L., Arsiwalla, T., Molist, F., Leushuis, R., Dalim, M., & Paul, A. (2020). Gradual provision of live black soldier fly (*Hermetia illucens*) larvae to older laying hens: Effect on production performance, egg quality, feather condition and behavior. *Animals*, 10(2), 216. <https://doi.org/10.3390/ani10020216>
- White, R., & Capper, J. L. (2014). Precision diet formulation to improve performance and profitability across various climates: Modeling the implications of increasing the formulation frequency of dairy cattle diets. *Journal of Dairy Science*, 97(3), 1563–1577. <https://doi.org/10.3168/jds.2013-6859>
- Wilkinson, J. M. (2011). Re-defining efficiency of feed use by livestock. *Animal*, 5(7), 1014–1022. <https://doi.org/10.1017/s175173111100005x>

Williams, S., Clarke, T., Hannah, M., Marett, L. C., Moate, P. J., Auldist, M., ... & Wales, W. J. (2013). Energy partitioning in herbage-fed dairy cows offered supplementary grain during an extended lactation. *Journal of Dairy Science*, 96(1), 484–494. <https://doi.org/10.3168/jds.2012-5787>

What is precision Feeding: https://youtu.be/jdm7h9vR_3Y

Demonstration Farm of IFIP: The French Technical Institute for PIGS : https://youtube/TvbZA_fb49Q

Nutritious varieties of grass in Uganda: <https://youtu.be/y6RHEFkQmQM?t=8>

PART 2 – CURRICULUM

Learning Objectives:

KNOWLEDGE	SKILLS	ATTITUDES
<p><i>Students will know:</i></p> <ul style="list-style-type: none"> ● The basic principles of animal nutrition, nutrient requirements, and feed types. ● Locally available Ugandan feed resources and how they contribute to balanced rations. ● Proper methods for feed processing, storage, and quality control. ● The concept of feed conversion ratio (FCR) and production efficiency. ● How Precision Feeding and Precision Livestock Farming (PLF) tools support decision-making in grazing and feeding management. ● Common challenges in Ugandan smallholder systems, including seasonal feed shortages and forage quality 	<p><i>Student will be able to:</i></p> <ul style="list-style-type: none"> ● Identify and classify different feed ingredients and evaluate their nutritional roles. ● Formulate simple, balanced rations using local ingredients. ● Recognise signs of poor feed quality, mold, and contamination. ● Calculate FCR and interpret feed efficiency and production data. ● Apply practical feeding strategies to improve animal health and productivity. ● Use simple PLF-inspired tools (e.g., mobile phone notes, observation checklists, simulated GPS data) to monitor behaviour, feed intake, and grazing patterns. 	<p><i>Student will develop the following mindset:</i></p> <ul style="list-style-type: none"> ● A proactive, problem-solving attitude toward improving feeding practices. ● Appreciation for sustainable, resource-efficient livestock management. ● Openness to adopting simple technologies or data-based decision-making methods. ● Responsibility for animal welfare and safe feed handling. ● Confidence in using local, low-cost feed resources creatively and effectively. ● Willingness to collaborate, share knowledge, and continuously learn to support resilience in smallholder Ugandan livestock systems.

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TRANSVERSAL SKILLS INTEGRATED:

- **Problem-solving:** Analyzing feeding challenges and proposing context-appropriate solutions.
- **Critical thinking:** Interpreting feed data, FCR results, and PLF information to make informed decisions.
- **Collaboration & Teamwork:** Working in groups during practical activities, simulations, and case studies.
- **Communication skills:** Presenting findings, explaining ration plans, and discussing management recommendations.
- **Adaptability:** Adjusting feeding strategies based on seasonal changes and resource availability.

DIGITAL SKILLS INTEGRATED:

- **Basic digital literacy:** Using smartphones for notes, photos, timers, and simple documentation of feeding and animal behaviour.
- **Data interpretation:** Understanding simple data outputs (e.g., FCR calculations, feed records, simulated PLF data).
- **Familiarity with digital tools:** Exposure to PLF concepts such as GPS tracking, mobile apps for ration planning, and digital observation logs.
- **Information management:** Recording, organizing, and using digital information to support decision-making.
- **Awareness of emerging technologies:** Understanding how digital innovations can improve grazing, feeding, and animal welfare.

GREEN SKILLS INTEGRATED:

- **Sustainable resource management:** Efficient use of local feed resources, reduction of waste, and improved pasture use.
- **Environmental awareness:** Understanding how better feed efficiency reduces environmental impact (e.g., lower emissions, reduced land pressure).
- **Climate resilience:** Adapting feeding strategies to seasonal variability and climate challenges common in Ugandan systems.
- **Circular economy thinking:** Using local by-products, crop residues, and alternative protein sources sustainably.
- **Biodiversity & land stewardship:** Promoting controlled grazing, preventing overgrazing, and protecting pasture ecosystems.

Implementation plan of pedagogical activities - Scheme of work

Duration: 3 hours				
Target: VET learners, smallholder farmers				
No. of Activity	Duration	Training Methods / Activity	What the trainers do	What the participants do
1	90 min	Introductory Trainer-Led presentation with video demonstration and interactive discussion	<ul style="list-style-type: none"> • Present key nutrition concepts, Feed Types, and local (Uganda) feed resources and Precision Feeding • Presentation of videos and guide participants to answer some key questions 	<ul style="list-style-type: none"> • Listen, take notes, ask questions. • Engage in short discussions. • Reflect on how theory applies to their context.
2	45 min	Problem-Based Learning (PBL): "Boosting Milk from a Smallholder Cow"	<ul style="list-style-type: none"> • Present the scenario of a cow with low milk yield due to poor feeding. • Facilitate group discussions • Support groups as they analyze the 	<ul style="list-style-type: none"> • Work in groups to analyse causes of low yield. • Apply nutrition knowledge to identify feed gaps. • Propose low-cost feeding solutions. • Present group findings.

			problem and propose feeding improvements.	
3	45 min	Measuring Feed Conversion Ratio and Production Efficiency	<ul style="list-style-type: none"> ● Explain FCR with examples. ● Provide FCR calculation worksheet ● Facilitate group interpretation and discussion ● Lead decision-making exercise. 	<ul style="list-style-type: none"> ● Calculate FCR using provided data. ● Discuss causes of poor efficiency. ● Select practical improvements to enhance FCR. ● Present group recommendations.
Materials (What trainers need to have prepared): <ul style="list-style-type: none"> ● Samples or pictures of common Ugandan feed ingredients (Napier grass, maize bran, cottonseed cake, legumes, crop residues) ● Flipchart or whiteboard + markers ● Printed scenario sheets 				
Other notes:				

PART 3 – ACTIVITY GUIDE

DESCRIPTION OF THE ACTIVITIES

1. Understanding Animal Nutrition, Feed Types, Precision Feeding and Precision Livestock Farming (Video Demos and interactive discussion)

This introductory presentation-based activity provides learners with a foundational understanding of animal nutrition and feed types. Using short videos, participants are introduced to essential nutrition concepts such as nutrient groups (protein, energy, minerals, vitamins, water) and the distinction between roughages and concentrates.

These concepts are contextualized within Ugandan smallholder systems, emphasizing locally available feed resources. Finally, the trainer presents an introduction to Precision Feeding and Precision Livestock Farming (PLF). Short videos are shown, helping participants to understand Precision Feeding and Precision Livestock Farming. This activity uses visual learning, guided discussion, and video-based demonstration to build knowledge, digital awareness, and curiosity about modern livestock feeding strategies.

1. Aim of the activity: The activity introduces essential concepts of animal nutrition, feed, and efficiency, helps learners understand the role of precision feeding and Precision Livestock Farming (PLF), and uses videos to enhance comprehension and engagement.

2. Duration: 90 min

3. Material required:

- Laptop + projector + speakers
- Flipchart / markers
- Videos:
 - Animal Nutrition (<https://youtu.be/tYSOIQpSG6A>)
 - What is the Difference between Roughage and Concentrates (<https://youtu.be/rKI80gtDAco>)
 - What is precision feeding (https://youtu.be/jdm7h9vR_3Y)
 - What is precision Livestock Farming (<https://youtu.be/kFg28Jdz2w8>)

4. Step-by-step instruction of the task:

- The trainer introduces the topic and shows the first video on animal nutrition to highlight key nutrient groups.
- The trainer shows the video on roughages and concentrates and asks learners to identify local examples.
- The trainer plays the videos on Precision Feeding and PLF, explaining how simple tools can improve feeding decisions.
- The trainer facilitates a short group discussion, summarizes key points on the flipchart, and answers questions.
 - Discussion questions
 1. Which locally available feeds can farmers use as roughages and concentrates in your area?
 2. How could precision feeding or PLF improve productivity and reduce costs on smallholder farms?

2. Boosting Milk from a Smallholder Dairy Cow: A Problem-Based Learning Scenario

This activity describes a real-life scenario from a typical Ugandan smallholder dairy household to help learners apply principles of animal nutrition, feed quality assessment, forage management, and low-cost ration improvement. Participants analyze a declining milk yield problem using the basics of animal nutrition, feed types, feed storage quality, and seasonal forage shortages. The trainer presents the case of a cow whose milk production has dropped due to poor feeding practices, low-quality forage, lack of supplements, and poor storage conditions.

Scenario:

The scenario takes place in a typical Ugandan smallholder dairy household where a lactating cow's milk yield has steadily declined in recent weeks. The cow is mainly fed over-mature Napier grass, small amounts of crop residues, and poorly stored feed that shows signs of mold, with no mineral or protein supplements provided. The problem is worsened by the dry season, which has reduced forage availability and forced the farmer to rely on low-quality, insufficient feeds.

Through group problem analysis, participants trace the root causes of low production: poor Napier grass quality, inadequate protein, absence of minerals, mold contamination, lack of feed measurement, and seasonal scarcity. Using local resources commonly found in Ugandan systems, learners propose practical, low-cost interventions.

The activity builds problem-solving, teamwork, critical thinking, and sustainable resource management skills. Learners must recommend a simple, realistic feeding plan for the farmer that increases milk yield without requiring expensive concentrates. By the end, participants understand how feed quality, storage, seasonality, and supplementation directly affect dairy performance, and they develop confidence in identifying practical, climate-smart feeding improvements suitable for smallholder Ugandan farms.

1. Aim of the activity: Diagnose real-life feeding problems using nutrition principles, apply feed evaluation, forage quality assessment, and seasonal feeding strategies, and design a low-cost, locally appropriate feeding improvement plan.

2. Duration: 45 min

3. Material required:

- Printed scenario sheets
- Feed samples or photos (Napier grass, maize bran, sweet potato vines, legumes, mineral block)
- Flipchart and markers

4. Step-by-step instruction of the task

- **Scenario Presentation:** Trainer presents the short scenario describing the cow with reduced milk yield and poor feeding practices, including moldy feed and seasonal shortages. Participants listen and ask clarifying questions.
- **Group Problem Analysis:** Participants form small groups. Trainer guides them to analyze: What the cow is currently fed; Nutrient gaps (protein, minerals, digestible energy); Effects of mold contamination; Consequences of harvesting Napier too late; Impact of dry-season shortages and groups list all possible causes of low milk yield on flipchart paper.
- **Identify Locally Available Solutions:** Groups suggest low-cost, local feeding improvements, such as: Harvesting Napier younger (higher protein); Adding protein-rich feeds (legume forages, sweet potato vines, *Lucerne*, *Calliandra*, *Desmodium*); Introducing a mineral lick; Improving storage to prevent mold; Making simple silage or hay for the dry season; Increasing feed quantity and ensuring consistency
- **Design a 1-Week Feeding Plan:** Groups create a simple, realistic feeding plan for the farmer using available Ugandan feed resources. They may take photos of feed samples, write notes digitally, or sketch a ration on flipchart paper.
- **Presentations & Quick brief:** Each group presents their recommended plan. Trainer highlights key improvements: feed quality, protein supplementation, minerals, storage, and dry-season preparedness.

References:

Blackwood, I., & Clayton, E. (2007, January). *Supplementary feeding of cattle* (Primefact 341; replaces Agnote DAI-184). NSW Department of Primary Industries.

European Commission. (n.d.). *Livestock systems*. European Commission – Agriculture and Rural Development. [livestock innovation systems](#).

Galla, N. A., Nampija, Z., Lutwama, V., Mayanja, S., Grant, F., Kyalo, G., Kiggundu, M., Zziwa, E., & Nambi-Kasozi, J. (2020). Effects of inclusion levels of sweet potato vine silage on feed intake, milk production and profitability of lactating crossbred dairy cows. *Open Journal of Animal Sciences*, *10*, 608–617. <https://www.scirp.org/journal/ojas>

White, R. R., & Capper, J. L. (2014). Precision diet formulation to improve performance and profitability across various climates: Modeling the implications of increasing the formulation frequency of dairy cattle diets. *Journal of Dairy Science*, *97*, 1563–1577. <https://doi.org/10.3168/jds.2013-6859>

3. Understanding Feed Conversion Ratio (FCR) and How to Improve Production Efficiency

This activity introduces trainees to the practical calculation of Feed Conversion Ratio (FCR), an essential metric for evaluating how efficiently animals convert feed into body weight. Using a realistic broiler chicken scenario, participants calculate FCR, interpret results, diagnose causes of poor efficiency, and propose practical changes to improve performance.

Scenario:

The scenario focuses on a small-scale broiler chicken farm where ten birds consumed 14 kg of feed but gained only 5 kg of total body weight, raising concerns about poor feed efficiency.

The trainer introduces Feed Conversion Ratio (FCR), explains its economic and environmental importance, and provides the data needed for participants to calculate and interpret the FCR. Working in groups, trainees analyze whether the calculated FCR indicates good or poor performance and discuss possible causes such as low-quality feed, heat stress, overcrowding, or health problems. Finally, each group proposes two low-cost, practical actions a farmer could implement immediately to improve FCR while supporting animal welfare and sustainable feeding practices. This encourages learners to link theory with practice and consider both animal welfare and climate-smart feeding decisions.

The activity builds numeracy, data interpretation, teamwork, and decision-making skills while reinforcing sustainable feed management principles outlined earlier in the module.

1. Aim of the activity: Build capacity to calculate and interpret FCR, identify factors affecting feed efficiency in poultry, and recommend simple practices to improve production efficiency.

2. Duration: 45 min

3. Material required:

- Scenario sheet (10 chickens, 14 kg feed, 5 kg total weight gain)
- Flipchart/markers
- Feed samples or photos (optional)

4. Step-by-step instruction of the task

- **Introduction & Concept Explanation:** Trainer explains: the definition and formula of FCR, link to feed costs, profitability, and environmental impact. Participants ask questions.

- **Group Hands-On Calculation:** Participants work in groups to calculate FCR using (Feed consumed = 14 kg, Weight gain = 5 kg) and groups decide whether FCR is good or poor.
- **Identify Causes of Poor FCR:** Groups discuss and list possible causes based on: genetics (unselected strains), nutrition (low protein, low digestibility), management (overcrowding, heat stress, poor ventilation) and health (disease, parasites).
- **Mini Decision-Making Exercise:** Each group selects two realistic improvements a farmer can implement next week. Examples include: adding a protein source, ensuring clean water, reducing overcrowding, removing moldy feed, improving temperature/ventilation, early treatment of sick birds and using probiotics, and the groups present their proposed solutions.

References/Sources/Further materials

Poompramun, C., Hennequet-Antier, C., Thumanu, K., Sinpru, P., Pengsanthia, S., Molee, W., Molee, A., Le Bihan-Duval, E., & Juanchich, A. (2021). Revealing pathways associated with feed efficiency and meat quality traits in slow-growing chickens. *Animals*, 11(10), 2977. <https://doi.org/10.3390/ani11102977> [mdpi.com](https://www.mdpi.com)+1

Video: Feed Conversion rates (<https://youtu.be/EmwS6linGos>)