



User guide for poultry feed formulation application

A comprehensive user manual
for the Feed Formulation App
Version 1.0

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April 2025

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ILRI thanks all donors and organizations which globally support its work through their contributions to the [CGIAR Trust Fund](#)



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Editing, design and layout—ILRI Editorial and Publishing Services, Addis Ababa, Ethiopia.

Cover photo—ILRI/Camille Hanotte.

ISBN: 92-9146-846-0

Citation: Esatu, W., Hoa, H.H., Huyen, N.T., Cuc, N.T.K., Phem, M., Tum, S., Chhay, T., Osei-Amponsah, R., Belete, S., Ouko, O., Goromela, E., Yemane, T. and Dessie, T. 2025. *User guide for poultry feed formulation application: A comprehensive user manual for the Feed Formulation App Version 1.0*. ILRI manual 78. Nairobi, Kenya: International Livestock Research Institute (ILRI).

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Contents

Legend	v
Glossary	vi
1 Introduction	1
2 Feed formulation in poultry farming	2
3 Poultry nutrients and their functions	3
3.1 Nutrient balancing	4
4 The role of feed formulation apps	5
4.1 Flexibility and sustainability in feed formulation	5
4.2 Affordable and sustainable feeding solutions	5
5 Protein requirements in poultry nutrition	7
5.1 Protein components and considerations	7
5.2 Common protein sources in poultry diets	8
6 Fatty acid requirement in poultry	9
6.1 Fatty acid considerations	9
7 Mineral requirements in poultry diets	10
7.1 Minerals considerations	10
7.2 Common sources of macro minerals	10
7.3 Mineral premixes for microminerals	10
7.4 Categories of vitamins in poultry nutrition	11
8 Common poultry feed ingredients and their recommended inclusion levels	12
8.1 Animal protein sources	12
8.2 Plant protein sources	12
8.3 Energy sources	13

9	Sign up	15
10	Login	17
11	Forgot password	18
12	Home page	19
13	Manage farm	20
14	How to formulate a ration	21
15	Ingredients	23
	15.1 View ingredient list	23
	15.2 Create new nutrient	23
16	Unit	25
	16.1 View unit list	25
	16.2 Archive records	25
	16.3 Create new unit	25
	16.4 Edit unit	26
	16.5 Delete unit	26
17	Nutrient groups	27
	17.1 View nutrient group list	27
	17.2 Archive records	27
	17.3 Create new nutrient group	27
	17.4 Edit nutrient group	27
	17.5 Delete nutrient group	28
18	Nutrient	29
	18.1 View nutrient list	29
	18.2 Archive records	29
	18.3 Create new nutrient	29
	18.4 Edit nutrient	30
	18.5 Delete nutrient	30
19	Contact info	31
20	Further reading	32

Legend

Name	Abbreviation	Unit	Description
Dry matter	DM	%	The dry matter or dry weight is a measure of the mass of a completely dried substance. ^a
Metabolizable energy	ME	kcal/kg	
Crude protein	CP	%	
Lysine	Lys	%	
Meth. + cystine	m+c	%	
Methionine	Met	%	
Ether extract	EE	%	
Crude fibre	CF	%	
Calcium	Ca	%	
Phosphorus	P	%	

^aNutrients on a dry matter basis (DMB) mean that the nutrient content of a feed is expressed without considering its moisture that varies significantly make the comparison less accurate.

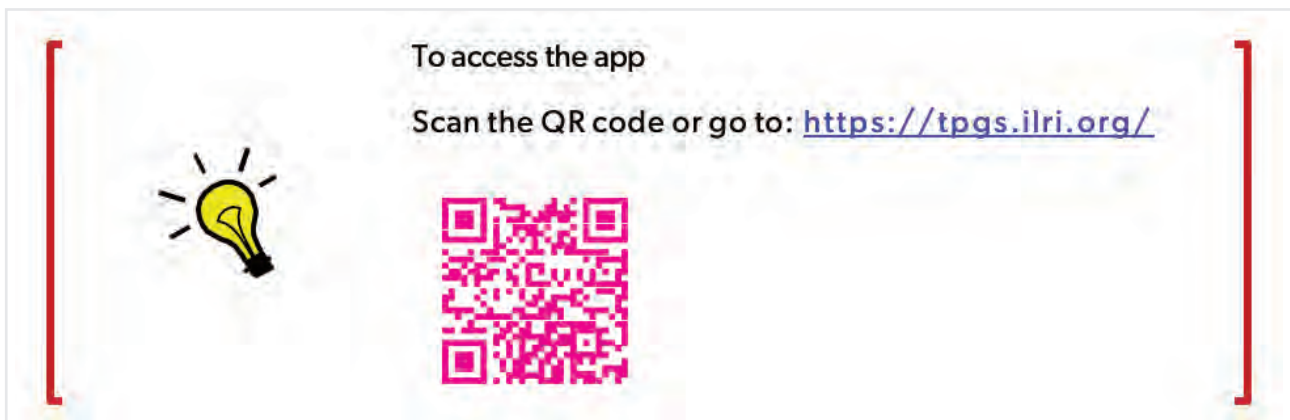
Glossary

Term	Definition
Ration	Refers to the specific amount and combination of ingredients provided to an animal over a set period (usually a day) to meet its nutritional requirements.
Formulation	The process of designing and creating a balanced diet for animals by selecting and combining various feed ingredients in precise amounts to meet the nutritional requirements of the animal.
Formula	The specific recipe or set of instructions used to create an animal's diet, detailing the precise quantities and types of ingredients required to meet the animal's nutritional needs (holds user's archived formulation).
Grid formulation	A method of feed formulation that uses a grid or matrix to determine the correct proportions of ingredients needed (Excel like formulation interface)
Ingredients	Various raw materials or substances that are combined to create animal feed.
Ingredient group	A category or classification of feed ingredients that share similar nutritional characteristics or functions within an animal's diet
Ingredient composition	Specific breakdown or profile of nutrients contained within a given feed ingredient. This composition includes the amounts of key nutrients, such as proteins, fats, carbohydrates, vitamins, EE, minerals, and fiber, that the ingredient provides when used in animal feed.
Nutrients	Refers to chemical components such as crude protein (CP), lysine (Lys), metabolizable energy (ME), ether extract (EE) and so on.
Nutrient group	A classification of essential nutrients based on their specific role and function in the animal's diet.
Requirements	The specific amounts of various nutrients that an animal needs to maintain health, grow, reproduce, and perform optimally.
Requirement composition	The specific balance and amounts of nutrients that must be provided in an animal's diet to meet its nutritional needs such as crude protein (CP), lysine (Lys), metabolizable energy (ME), ether extract (EE) and so on.
Requirement boundaries (min and max)	Refer to the specific ranges of nutrient levels (minimum and maximum) that are necessary to maintain
Ration	The balanced diet after formulation (is referred against the selected requirements)

1 Introduction

This user guide outlines the TPGS poultry feed formulation, designed for users with basic knowledge of nutrition and feeds. It offers a dynamic platform where ingredients and nutritional compositions can be edited. Users can save, share, or print their formulations, and the guide can be continuously improved with new features based on feedback. It is free for national partners, smallholders, and semi-commercial producers who formulate their own poultry feed using available ingredients.

Access the website using either the below URL or QR code.



2 Feed formulation in poultry farming

Feed formulation is crucial in poultry farming, as it directly impacts chicken health, growth and productivity. Properly formulated feed ensures that chickens receive the right balance of essential proteins, carbohydrates, fats, vitamins and minerals—which are necessary for optimal growth, egg production and overall health. A well-balanced diet not only enhances growth and reproduction but also helps reduce disease risk, improves feed conversion rates and lowers production costs. However, feed formulation is not a one-size-fits-all solution. It must account for factors such as the chicken's age, breed, production purpose (meat, egg, or breeding) and environmental conditions. Achieving the right balance requires knowledge of nutritional needs, available feed ingredients and local farming conditions.

3 Poultry nutrients and their functions

Poultry feed contains several essential nutrients, each playing a vital role in chicken health, growth and productivity. These nutrients include:

- **Proteins and amino acids**
Function: Proteins are building blocks for growth, muscle development, tissue repair and egg production. Amino acids like lysine and methionine are essential for optimal growth.
Sources: Soybean meal, fish meal, alfalfa.
- **Carbohydrates**
Function: Provide the primary energy source for chickens, supporting heat production, activity and metabolism.
Sources: Corn, wheat, rice, barley.
- **Fats (lipids)**
Function: Provide concentrated energy, assist in fat-soluble vitamin absorption and support cell structure.
Sources: Vegetable oils, fish oils, seeds.
- **Vitamins**
Function: Support immune health, metabolism and tissue development. Key vitamins include A, D, E and B vitamins (B12, niacin, folic acid).
Sources: Vegetables, fruits, liver, fish meal, yeast.
- **Minerals**
Function: Essential for bone development, enzyme function and electrolyte balance. Calcium and phosphorus are critical for bone health and eggshell formation.
Sources: Limestone, dicalcium phosphate, salt, trace minerals.
- **Water**
Function: Vital for digestion, nutrient absorption, temperature regulation and overall cellular function.
Sources: Clean, fresh water is essential for hydration.
- **Fibre**
Function: Aids in digestion and gut health, supporting motility and proper droppings formation.
Sources: Wheat bran, vegetable matter, rice hulls.
- **Antioxidants**
Function: Protect cells from oxidative damage and support immune function. Vitamin E and selenium are key antioxidants.
Sources: Vegetable oils, selenium-enriched grains.
- **Enzymes**
Function: Improve feed efficiency by aiding in digestion and nutrient absorption.
Sources: Naturally occurring in feed or supplemented.

3.1 Nutrient balancing

For optimal poultry health and productivity, nutrient balance is key. For example:

- An imbalance of calcium and phosphorus can affect bone health or eggshell quality.
- A proper balance between protein and energy is crucial to support growth, laying, or meat production, depending on the bird's purpose.

4 The role of feed formulation apps

Recent technologies have simplified feed formulation through user-friendly apps. These apps make the complex process of creating a balanced poultry diet accessible to both smallholder farmers and large-scale producers. The apps offer features that streamline the formulation process such as:

- **Simple interface:** Intuitive design for users with varying technical expertise, allowing them to input chicken details (age, weight, goals) and get customized feed recommendations.
- **Ingredient database:** Comprehensive databases that include local and international feed ingredients, enabling users to create balanced rations with familiar or locally available resources.
- **Nutrient balancing:** Automatically adjusts feed formulations to meet specific nutritional requirements, ensuring proper growth, egg production, or other specific outcomes.
- **Cost optimization:** Users can input local feed prices, helping them create cost-effective formulations without compromising on nutritional quality.
- **Sustainability and local resources:** Apps support sustainable practices by recommending locally available feed resources, reducing reliance on imported ingredients and minimizing waste.
- **Data-driven insights:** Some apps provide analytical tools to track feed efficiency, growth rates and other performance metrics, enabling informed decision-making.

4.1 Flexibility and sustainability in feed formulation

Feed formulation apps allow flexibility in using locally available feed ingredients, especially in regions where commercial feed is expensive or inaccessible. These apps help farmers utilize alternative feed sources such as grains, legumes, agricultural bodies and even insects, to develop affordable and sustainable feeding strategies. Locally sourced ingredients are often cheaper and help reduce dependency on external suppliers, contributing to the local economy.

Furthermore, the use of agro-industrial by-products (e.g., rice bran, cassava leaves) is encouraged, fostering a circular agricultural economy. These practices not only lower feed costs but also support long-term sustainability in poultry farming by reducing waste.

4.2 Affordable and sustainable feeding solutions

Feed formulation apps support affordable and sustainable feeding solutions by:

- **Optimizing feed costs:** Ensuring efficient use of local ingredients and minimizing waste.

- **Preventing overfeeding or underfeeding:** Correctly balancing the diet helps avoid unnecessary expenses or health issues related to improper feeding.
- **Supporting sustainability:** By promoting locally available ingredients and reducing reliance on costly commercial feed, apps help ensure the sustainability of poultry farming in the long term.

5 Protein requirements in poultry nutrition

Meeting the amino acid requirements of poultry through balanced protein sources is essential for optimal growth, productivity and product quality. By carefully selecting and balancing protein ingredients, poultry producers can formulate diets that support both economic and nutritional efficiency.

5.1 Protein components and considerations

Essential amino acids

- Poultry cannot synthesize essential amino acids, which include methionine, lysine, threonine and tryptophan, among others. Therefore, these amino acids must be supplied through dietary protein sources.
- The **quality of a protein** source is often judged by its amino acid profile, specifically whether it contains adequate amounts of these essential amino acids. High-quality protein sources will meet poultry's requirements for essential amino acids, which are critical for muscle growth, feathering and production performance.

Multiple protein sources

- **No single ingredient provides** all essential amino acids in the necessary proportions for poultry. Consequently, formulating a balanced poultry ration requires combining multiple protein sources. This ensures the diet includes a well-rounded profile of amino acids.
- Typically, poultry diets are formulated with a mix of plant-based proteins (like soybean meal, corn gluten meal, or canola meal) and, if permitted, animal-based proteins (such as fish meal or meat and bone meal).

Limiting amino acids

- **Methionine and lysine** are known as the 'limiting amino acids' in poultry nutrition. They are often present in lower quantities in most ingredients relative to the birds' requirements, which can restrict growth if not supplemented adequately.
- Synthetic forms of these amino acids such as **DL-methionine** and **L-lysine**, are commonly added to poultry feed to meet these requirements. Supplementing these amino acids improves protein utilization in diet and reduces the need for excess dietary protein.

Antinutritional factors (ANFs):

- Poultry, particularly chickens, are sensitive to **antinutritional factors** (ANFs) that are present in some plant-based feed ingredients. ANFs such as trypsin inhibitors in raw soybeans or tannins in some legumes, can interfere with protein digestion and amino acid absorption.
- Processing methods, like heat treatment, are used to reduce ANFs in ingredients like soybean meal, making them safer and more digestible for poultry.

Fish meal consideration

- **Fish meal** is a rich source of protein and essential amino acids, particularly lysine and methionine. However, when included at levels above **5% of the total diet**, it can impart a fishy taste to poultry meat and eggs.
- For this reason, fish meal is usually limited in poultry diets unless the birds are not raised for human consumption or taste alteration is not a concern.

5.2 Common protein sources in poultry diets

- **Soybean meal:** A high-quality plant protein with a good balance of essential amino acids, widely used in poultry diets.
- **Corn gluten meal:** Provides protein and energy, but is low in lysine, so it needs to be balanced with other ingredients.
- **Fish meal:** High in lysine and methionine but limited due to its potential effect on meat and egg flavour.
- **Meat and bone meal:** Provides animal protein and minerals like calcium and phosphorus but is restricted in some countries due to regulatory concerns.
- **Synthetic amino acids:** DL-methionine and L-lysine are often supplemented to ensure the diet meets the birds' requirements.

6 Fatty acid requirement in poultry

6.1 Fatty acid considerations

Essential fatty acid requirement

- Linoleic acid is classified as an essential fatty acid for poultry because birds lack the necessary enzymes to synthesize it from other nutrients. This means it must be supplied through the diet. Essential fatty acids are crucial for maintaining cellular membrane integrity, immune function and skin health in poultry.
- Studies show that linoleic acid is particularly important for growth, feathering and reproductive health in poultry. Deficiency in linoleic acid can lead to poor growth rates, reduced egg production and impaired egg hatchability in breeders.

Dietary role of fat in poultry nutrition

- Fats or oils are added to poultry diets not only as a concentrated energy source but also to improve nutrient absorption, particularly for fat-soluble vitamins (A, D, E and K). These vitamins are essential for various physiological functions, including bone development, antioxidant defence, immune function and reproduction.
- Fat helps reduce the dustiness of feed, making it more palatable and less likely to cause respiratory irritation. Improved palatability also encourages feed intake, supporting growth and productivity.

Antioxidants in fat-containing poultry diets

- When fats or oils are added to poultry diets, there is a risk of lipid oxidation, which can lead to rancidity. Rancid fats can reduce feed palatability and degrade fat-soluble vitamins, impacting the bird's health and performance.
- Antioxidants such as ethoxyquin, BHT (butylated hydroxytoluene) and vitamin E are commonly included in fat-containing poultry feeds to prevent oxidation. By preserving the stability of dietary fats, antioxidants help maintain the nutritional quality of the feed.

7 Mineral requirements in poultry diets

7.1 Minerals considerations

Macro minerals vs. micromineral

- Poultry require high levels of **macro minerals** and low levels of **microminerals** to support essential physiological functions.
- **Macro minerals** include calcium (Ca), phosphorus (P), chloride (Cl), magnesium (Mg), potassium (K) and sodium (Na). These minerals are needed in larger amounts as they play crucial roles in skeletal development, electrolyte balance, nerve function and muscle contraction in poultry.
- **Microminerals** (or trace minerals) include copper (Cu), iodine (I), iron (Fe), manganese (Mn), selenium (Se) and zinc (Zn). Although required in smaller quantities, microminerals are vital for enzyme function, immune response, antioxidant defence and thyroid function.

Mineral deficiency in grain

- Grains, which are often a primary energy source in poultry diets, tend to be low in both macro minerals and microminerals. Consequently, poultry diets require supplementation to ensure birds receive adequate mineral levels for optimal growth, health and productivity.

7.2 Common sources of macro minerals

- **Calcium (Ca):** Calcium is critical for bone health and eggshell formation in laying hens. Common sources include limestone and oyster shell, both of which are highly bioavailable forms of calcium. Limestone is often used in broiler diets, while oyster shell is more common in layer diets for sustained calcium release.
- **Phosphorus (P):** Dicalcium phosphate is a primary source of both phosphorus and calcium in poultry diets. Phosphorus works in tandem with calcium for bone development and metabolic functions.
- **Other macro minerals:** Sodium and chloride are often provided through salt (NaCl), which maintains electrolyte balance, while potassium is naturally present in some feed ingredients or provided through potassium chloride as needed.

7.3 Mineral premixes for microminerals

- **Microminerals** are supplied in a **mineral premix**, which is added to the feed in small amounts. The premix is carefully formulated to provide the necessary levels of each trace mineral without risking toxicity. For example, zinc and manganese are essential for bone and immune health, while selenium functions as an antioxidant, protecting cells from oxidative damage.

7.4 Categories of vitamins in poultry nutrition

- **Fat-soluble vitamins (A, D, E and K)**

These vitamins are essential for various physiological functions:

Vitamin A: Crucial for vision, immune function and growth.

Vitamin D: Important for calcium absorption, bone formation and eggshell quality.

Vitamin E: Acts as an antioxidant, protecting cells from oxidative damage and supports immune function.

Vitamin K: Needed for blood clotting and bone health.

Since these vitamins are stored in body fat, they need to be provided in moderate, consistent amounts to prevent deficiency or toxicity.

- **Water-soluble vitamins (vitamin C and B vitamins)**

Vitamin C: Poultry can synthesize vitamin C, so it is not usually required in diets. However, it can be beneficial during periods of stress (e.g., heat stress) to improve resilience and support immune function.

B Vitamins: This group includes thiamine, riboflavin, niacin, pantothenic acid, pyridoxine, biotin, folic acid and vitamin B12. B vitamins are essential for energy metabolism, nerve function and growth.

These vitamins are not stored in the body, so they largely need to be provided continuously in the diet.

- **Endogenous and exogenous vitamin sources**

While poultry can produce certain vitamins endogenously, particularly vitamin C and some B vitamins through microbial synthesis in the digestive tract, it's often insufficient to meet their complete nutritional needs.

- **Feed ingredients as vitamin sources:** Some vitamins are naturally present in feed ingredients. For example, alfalfa meal and distillers' dried soluble contain B vitamins and may contribute to the overall vitamin content of the diet. However, levels can vary significantly based on processing and storage conditions.

- **Vitamin Premix for Consistency:**

A vitamin premix is typically included in poultry diets to ensure consistent vitamin intake, compensating for the variability in vitamin content of natural feed ingredients. Premixes are formulated to provide the optimal levels of vitamins needed for growth, reproduction and health.

8 Common poultry feed ingredients and their recommended inclusion levels

Below is the list of common poultry feed ingredients, including their general inclusion rates and safe limits for use in poultry feed formulations. The actual proportions can vary based on poultry type (broilers, layers, breeders) and production stage (starter, grower, finisher). Note that ingredient availability, nutrient composition and cost can also influence ingredient usage. Safe minimum and maximum ranges are essential for balancing nutrition and preventing toxicity or health issues. A list of commonly used poultry feed ingredients, categorized into animal and plant protein sources, along with their safe minimum and maximum inclusion levels in feed formulation is presented in Table 1 to 4.

8.1 Animal protein sources

Animal protein sources provide essential amino acids, vitamins and minerals but must be carefully monitored to avoid imbalances in nutrients and excessive levels of heavy metals.

Table 1. Commonly used animal and their safe minimum and maximum inclusion levels in feed formulation

Ingredient	Safe min (%)	Safe max (%)	Purpose	Notes and safe usage
Fish meal	2	10	High-quality protein, omega-3	Ensure quality control to avoid spoilage and rancidity. High in phosphorus.
Meat and bone meal	0	5	Protein and calcium source	Provides phosphorus and calcium but has variable protein quality. Limit to avoid imbalances in non-layers.
Blood meal	0	3	Protein, high lysine content	Use with caution due to high protein concentration. Limit to avoid palatability issues.
Feather meal	0	5	Protein, primarily keratin	High in cysteine but low in digestibility unless hydrolysed.
Poultry by-product meal	0	10	Protein, vitamins, minerals	Quality depends on source, limit due to high ash content.
Dried whey	0	5	Lactose, protein source	Rich in lactose but limited use in poultry, as adult birds lack lactase enzyme.
Shrimp/crab meal	0	5	Protein, chitin source	High-quality protein: chitin has health benefits but use sparingly.

8.2 Plant protein sources

Plant proteins are widely used in poultry feed, providing essential amino acids like methionine and lysine. Many plant protein sources need processing to remove antinutritional factors.

Table 2. Commonly used plant protein sources and their safe minimum and maximum inclusion levels in feed formulation

Ingredient	Safe min (%)	Safe max (%)	Purpose	Notes and safe usage
Soybean meal	15	35	Protein source, high lysine	Widely used and requires heat treatment to deactivate antinutritional factors.
Canola meal	0	10	Protein source, moderate lysine	Limit due to glucosinolates, which can impair thyroid function.
Sunflower meal	0	10	Protein source, rich in fibre	High fibre limits use in young chicks but is suitable for layers.
Cottonseed meal	0	5	Protein source, high fibre	Use cautiously due to gossypol content, which can be toxic.
Peanut meal	0	5	Protein source	Limited by aflatoxin risk; high lysine but lacking in methionine.
Sesame meal	0	5	Protein source, high methionine	Use for balancing amino acid profile.
Alfalfa meal	0	5	Protein and vitamins	Rich in fibre and beta- carotene; limit for young birds.
Corn gluten meal	0	10	Protein and energy source	High methionine: bright yellow but limit due to low lysine.

8.3 Energy sources

Energy sources are crucial for supporting the high metabolic needs of poultry, especially in growth and egg production.

Table 3. Commonly used energy sources and their safe minimum and maximum inclusion levels in feed formulation

Ingredient	Safe min (%)	Safe max (%)	Purpose	Notes and safe usage
Corn/maize	30	60	Primary energy source	Avoid mycotoxins; easy to digest.
Wheat	10	50	Energy and protein	Limit due to potential gut viscosity; enzymes may improve digestibility.
Barley	0	15	Energy, fibre source	Use enzyme supplements to prevent gut issues.
Sorghum	0	30	Energy	Lower energy than corn; no antinutritional factors but can vary in quality.
Oats	0	10	Energy, high fibre	High fibre limits use in broilers; suitable for layers in moderation.
Rice bran	0	10	Energy, protein, fibre	High in fat; limit to prevent rancidity and high fibre.
Vegetable oils	1	5	High-energy source	Added for extra energy, it requires antioxidants to prevent rancidity.

8.4 Minerals and additives

Mineral sources are essential for skeletal health, eggshell formation and metabolic functions. Additives like enzymes and antioxidants improve feed quality.

Table 4. Commonly used mineral and additive sources and their safe minimum and maximum inclusion levels in feed formulation

Ingredient	Safe min (%)	Safe max (%)	Purpose	Notes and safe usage
Limestone	0.5	7	Calcium source	Essential for layers; lower levels for broilers.
Dicalcium phosphate	0.5	2	Phosphorus source	Crucial for bone health; ensure proper balance with calcium.
Salt (NaCl)	0.25	0.5	Electrolyte balance	Essential but avoid excessive levels to prevent toxicity.
DL-methionine	0.1	0.3	Essential amino acid	Balances amino acid profile, improves growth.
Lysine	0.05	0.3	Essential amino acid	Improves protein quality in feed.
Enzyme additives	0	0.1	Digestibility enhancer	Particularly useful with wheat or barley-based diets.
Antioxidants	0	0.05	Preserve feed quality	Added to prevent fat rancidity.
Coccidiostats	0	0.05	Disease prevention	Commonly used to prevent coccidiosis in broilers.

9 Sign up

1. Access the website using the URL (<https://tpgs.ilri.org/>). If you already have an account proceed to login by following **Section 10**.
2. Enter the required information (full name, email address and message), Click 'Submit' and wait for email response.

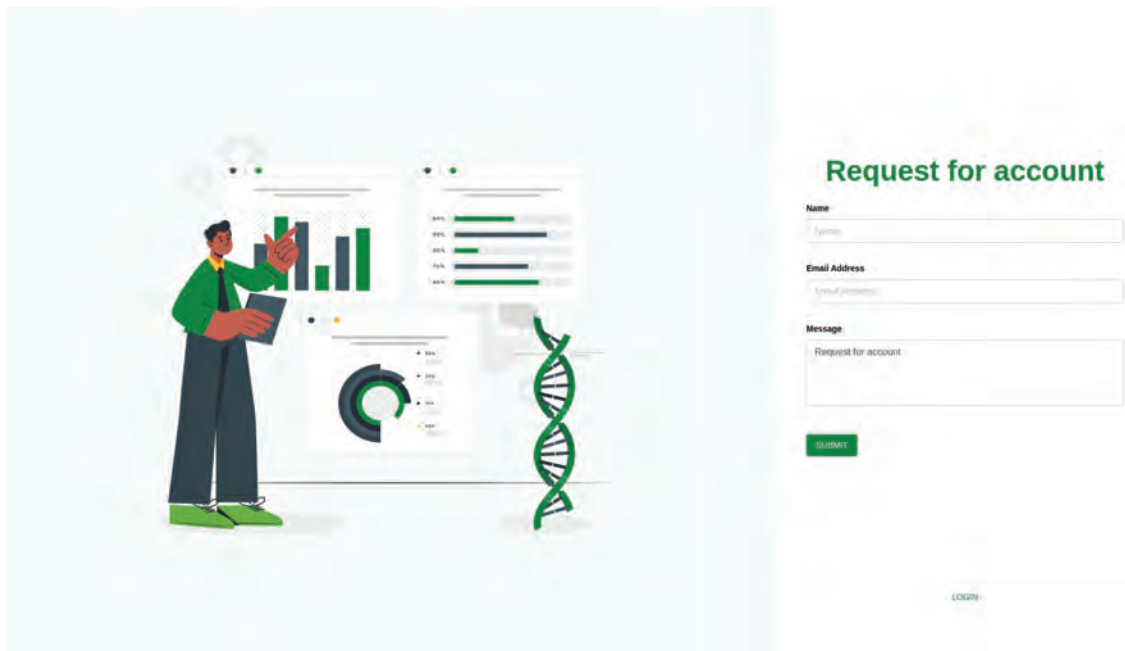
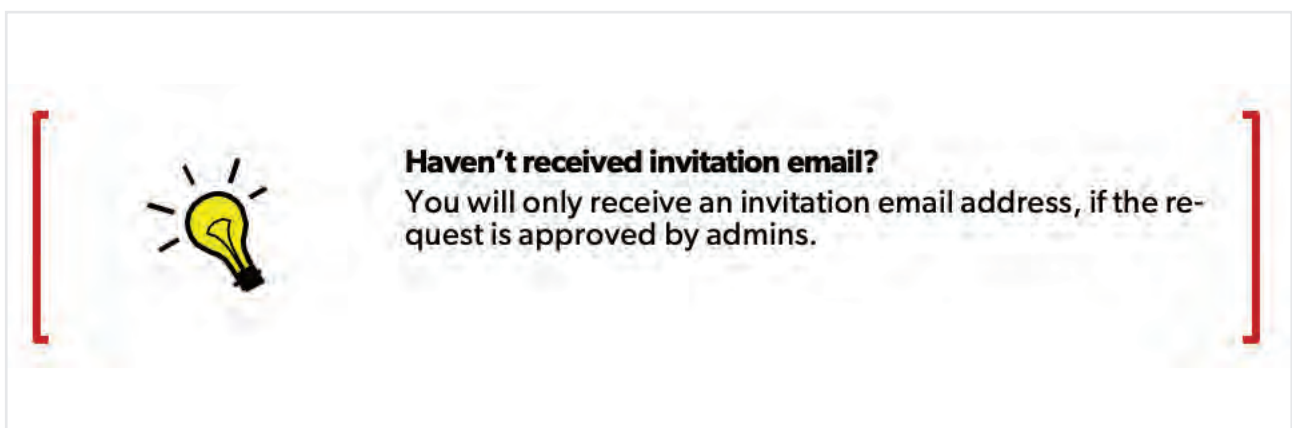


Figure 1: Sign-up page.

3. Go to your email inbox to create new account.



Click 'Join' and you will be redirected to account creation page. Enter the required fields and click '**CREATE NEW ACCOUNT.**'



Figure 2: Verify invitation page.

10 Login



Figure 3: Login page.

11 Forgot password

In order to reset your password head to <https://tpgs.ilri.org/forgot-password>

Provide your email address and click '**RESET**' button and a password reset email will be sent to the given email address.



Figure 4: Forgot password page.

12 Home page

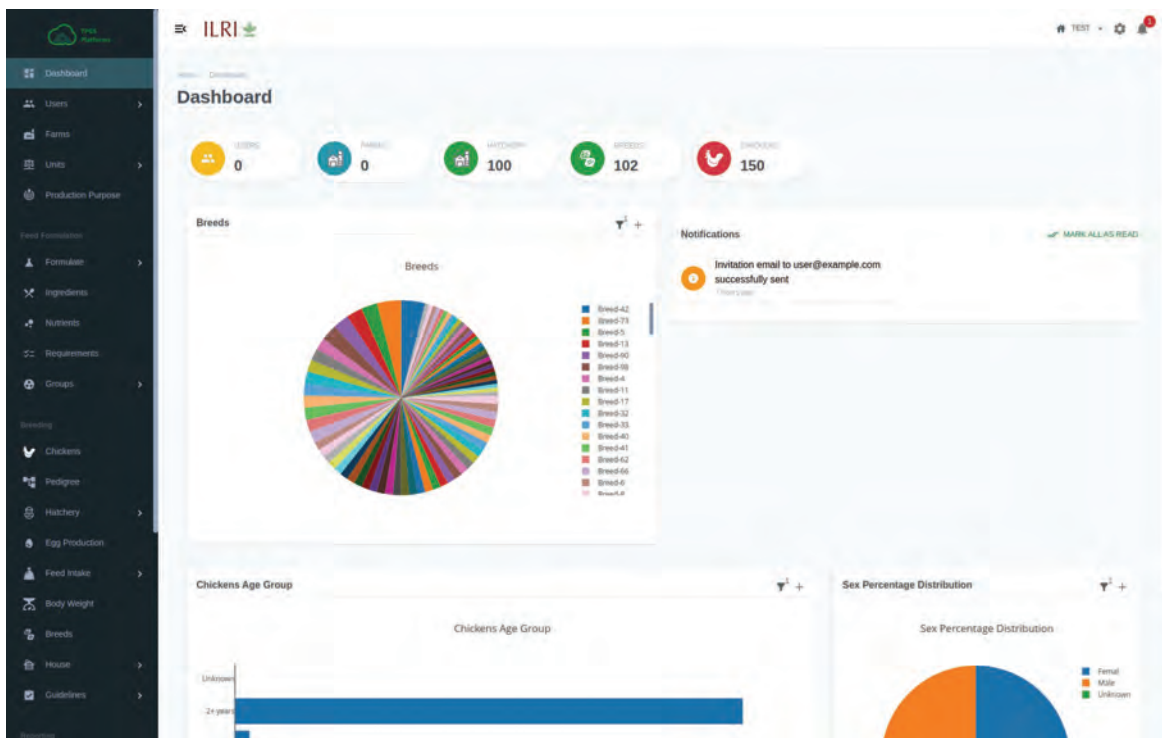


Figure 5: Dashboard page.

13 Manage farm

Switch farm either by going to **Farms** menu or by clicking on top right farm menu.

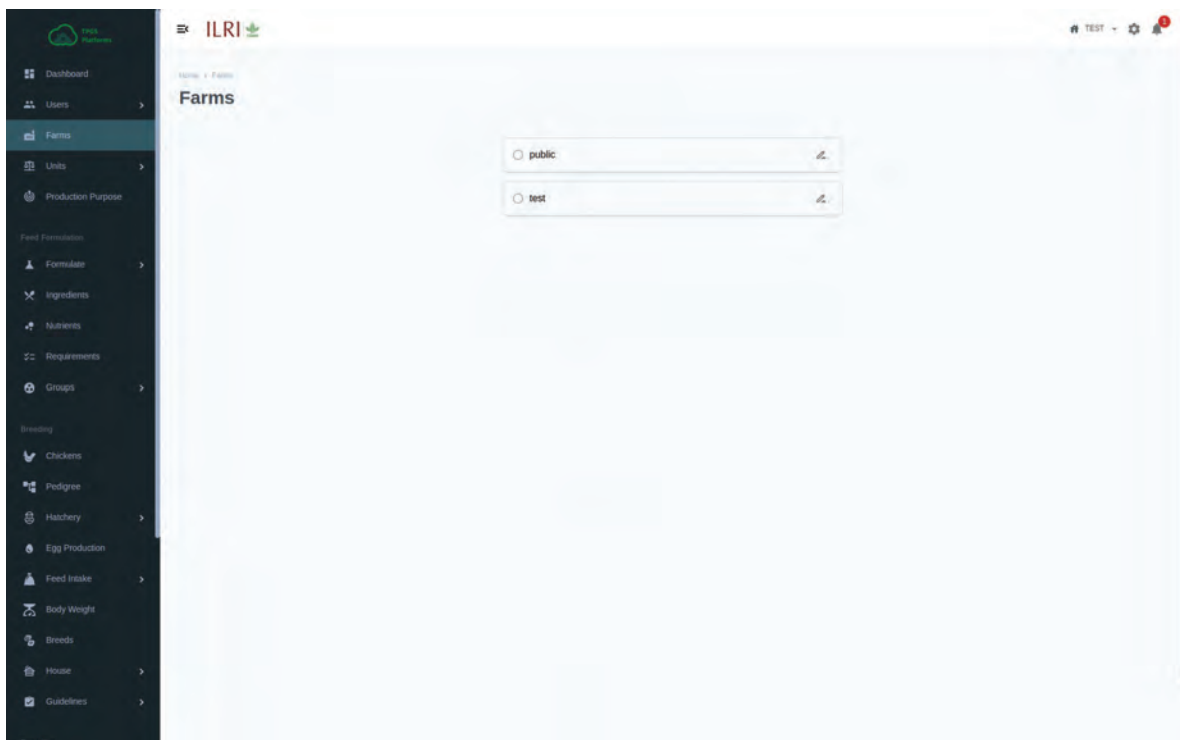


Figure 6: Switch farms page.

14 How to formulate a ration

1. On left sidebar menu expand '**Formulate**' menu then select 'New Formula' menu, then you will be redirected to ration formulation page.

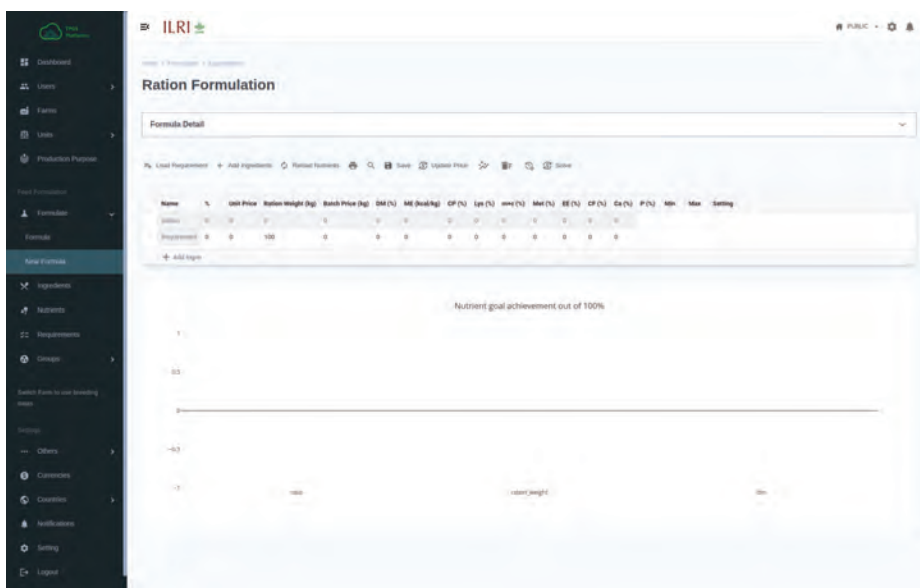


Figure 7: Ration formulation page.

2. Select the type of ration you want to prepare by clicking on '**Load Requirement.**'

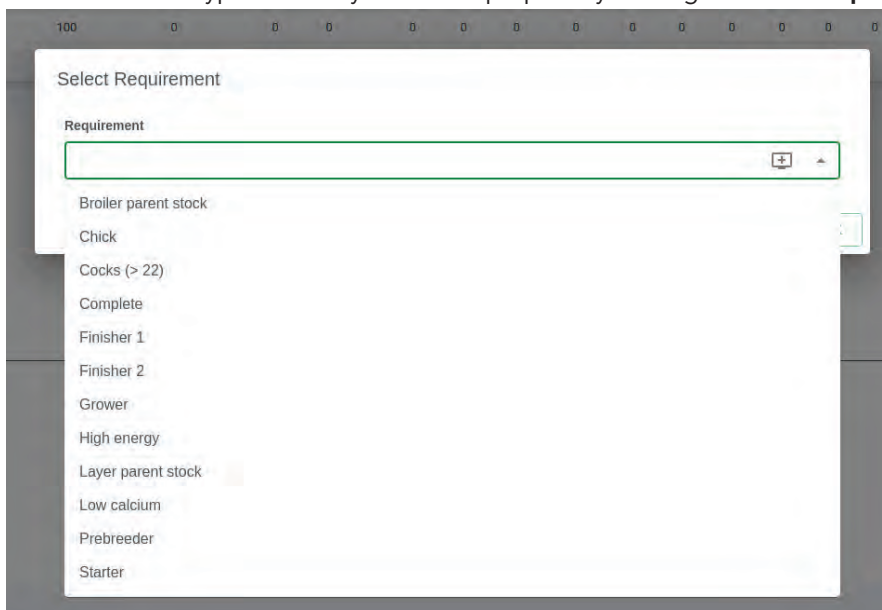


Figure 8: Load requirement.

3. Click **'Add Ingredients'** to include the required ingredients.

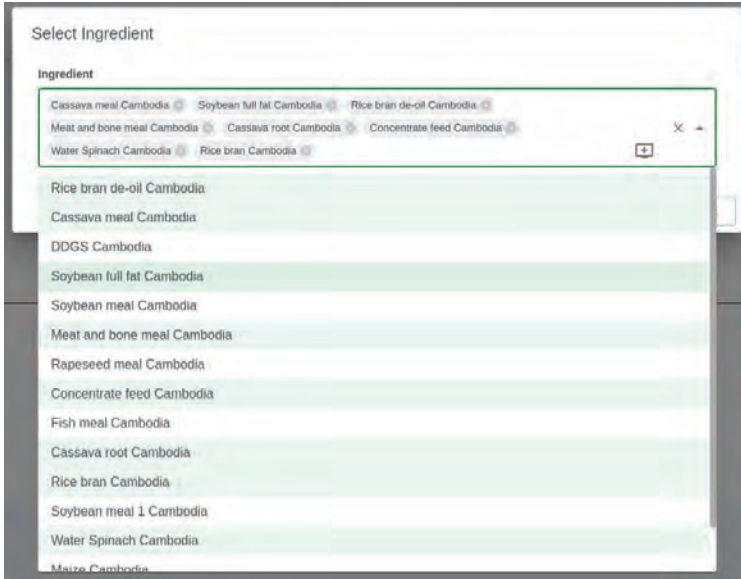


Figure 9: Select multiple ingredients

4. If the ingredient you wish to use in your ration is unavailable See Section 15.2
5. Change the '%' column per 100 kg by double-clicking on it to formulate your ration.
6. Once the ration formulation is complete, it can be saved as an archive or printed.

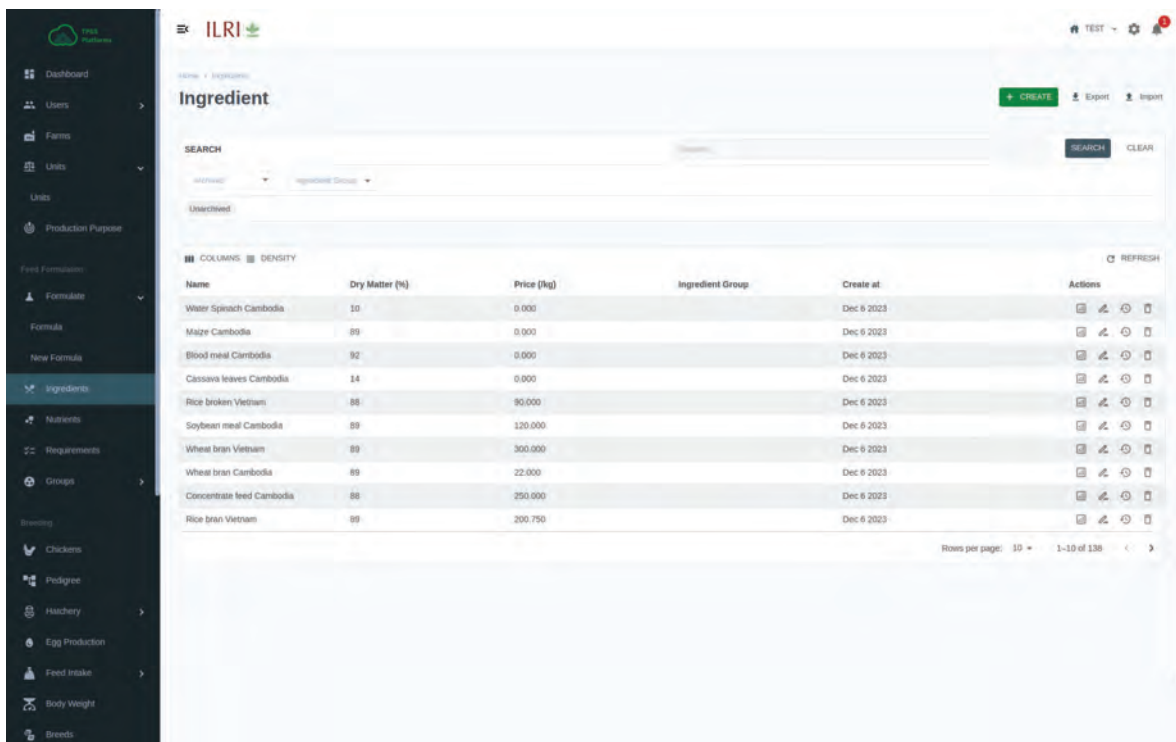
To update the ingredients with the current price, click 'Update price'

Remark: If you want to do further analysis on formulated ration, click the graph icon

15 Ingredients

15.1 View ingredient list

1. In order to access list of ingredients click on **'Ingredients'** menu from the sidebar.



Name	Dry Matter (%)	Price (kg)	Ingredient Group	Create at	Actions
Water Spinach Cambodia	10	0.000		Dec 6 2023	[Edit] [Delete] [Refresh]
Maize Cambodia	89	0.000		Dec 6 2023	[Edit] [Delete] [Refresh]
Blood meal Cambodia	92	0.000		Dec 6 2023	[Edit] [Delete] [Refresh]
Cassava leaves Cambodia	14	0.000		Dec 6 2023	[Edit] [Delete] [Refresh]
Rice broken Vietnam	88	90.000		Dec 6 2023	[Edit] [Delete] [Refresh]
Soybean meal Cambodia	89	120.000		Dec 6 2023	[Edit] [Delete] [Refresh]
Wheat bran Vietnam	89	300.000		Dec 6 2023	[Edit] [Delete] [Refresh]
Wheat bran Cambodia	89	22.000		Dec 6 2023	[Edit] [Delete] [Refresh]
Concentrate feed Cambodia	88	250.000		Dec 6 2023	[Edit] [Delete] [Refresh]
Rice bran Vietnam	89	200.750		Dec 6 2023	[Edit] [Delete] [Refresh]

Figure 10: Ingredients list.

2. Filter the list of ingredients by using the **'SEARCH'** card.

15.2 Create new nutrient

1. To create new ingredient, click on **'Create'** from Ingredients (Refer to Figure 20)
2. Input the necessary information about the ingredient and click on **'CREATE'** button
3. After the ingredient is created, a **'COMPOSITION'** will appear at the top.
4. Set ingredient's composition by clicking **'Add New'** and choosing the type of nutrient.

The screenshot displays the 'Water Spinach Cambodia - Edit' form in the ILRI Feed Formulation App. The form is divided into several sections:

- Ingredient Detail:** This section contains the following fields:
 - Name:** Water Spinach Cambodia
 - Code:** Code
 - Ingredient Group:** A dropdown menu with a plus icon.
 - Unit Price (kg):** 0.000
 - Dry Matter (%):** 10
 - Description:** Description
- Actions:** At the bottom of the form, there are two buttons: 'UPDATE' (green) and 'CANCEL' (red).

The right sidebar provides additional information and actions:

- Date Created:** Dec 6 2023
- Created by:** Unknown
- Last updated:** Dec 6 2023
- Last Updated by:** Admin
- Histories:** 1 Changes
- View:** A button to view the history.
- Archive:** A button to archive the record.
- Delete:** A button to delete the record.

Figure 11: Create new nutrient.

- To set value to nutrient double click on value column to corresponding row, the value will be automatically saved once you are done editing.

16 Unit

16.1 View unit list

1. Click on **'Unit'**

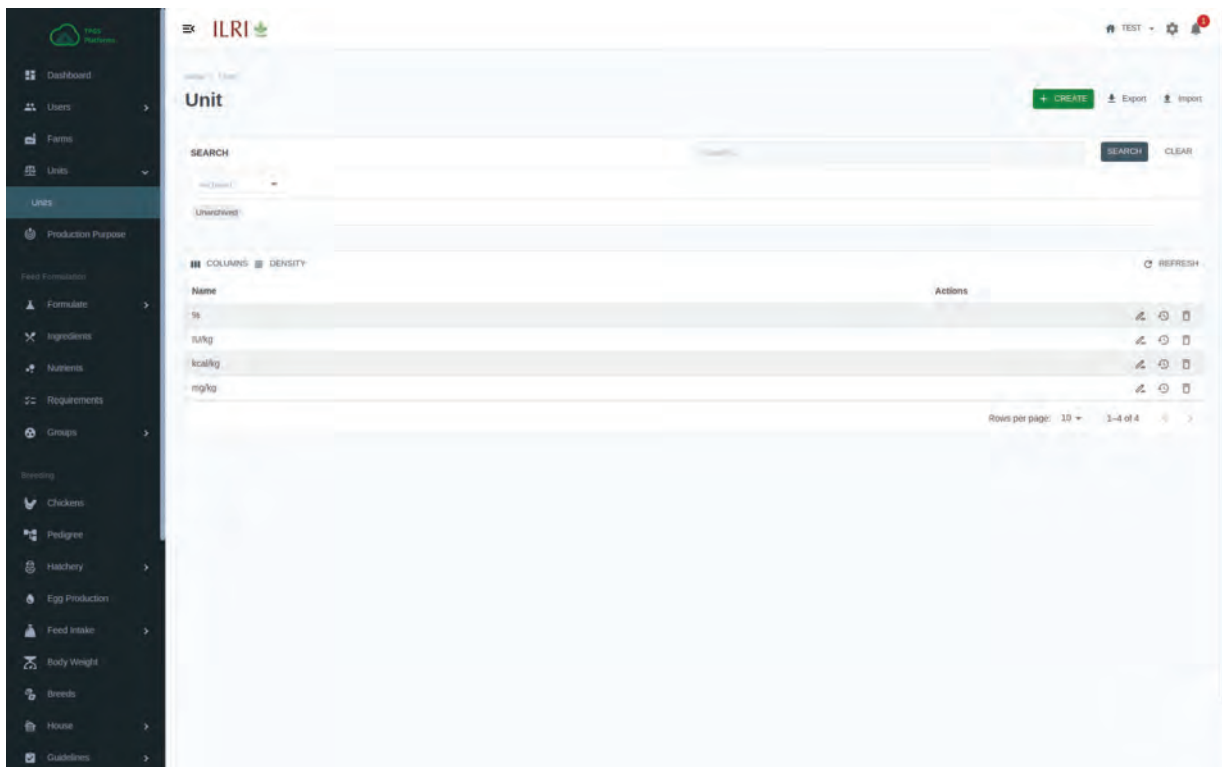


Figure 12: Unit list.

16.2 Archive records

1. On filter section filter the records by archive.

16.3 Create new unit

1. To create new unit click on **'Create'** Refer Figure 12 and click **'CREATE'**, you will be redirect to Section 16.1

16.4 Edit unit

1. Go to the Unit Refer to Section 16.1, then click on Pencil icon and it will redirect to the Figure 15.

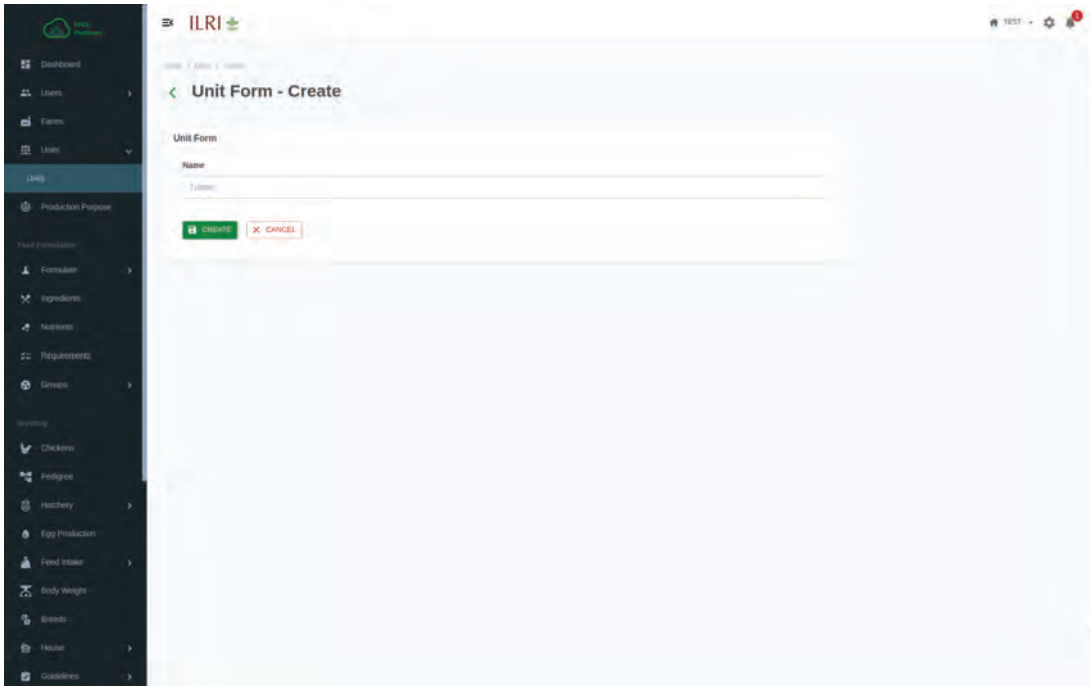


Figure 13: Create new nutrient group.

16.5 Delete unit

1. Go to the edit Unit Refer to Section 16.4.
2. To archive the record, click on 'Archive'. If you want to bring back the record/unarchive follow the step under Section 16.2 and click on 'Unarchive'
3. To permanently delete the record, click on 'Delete'.

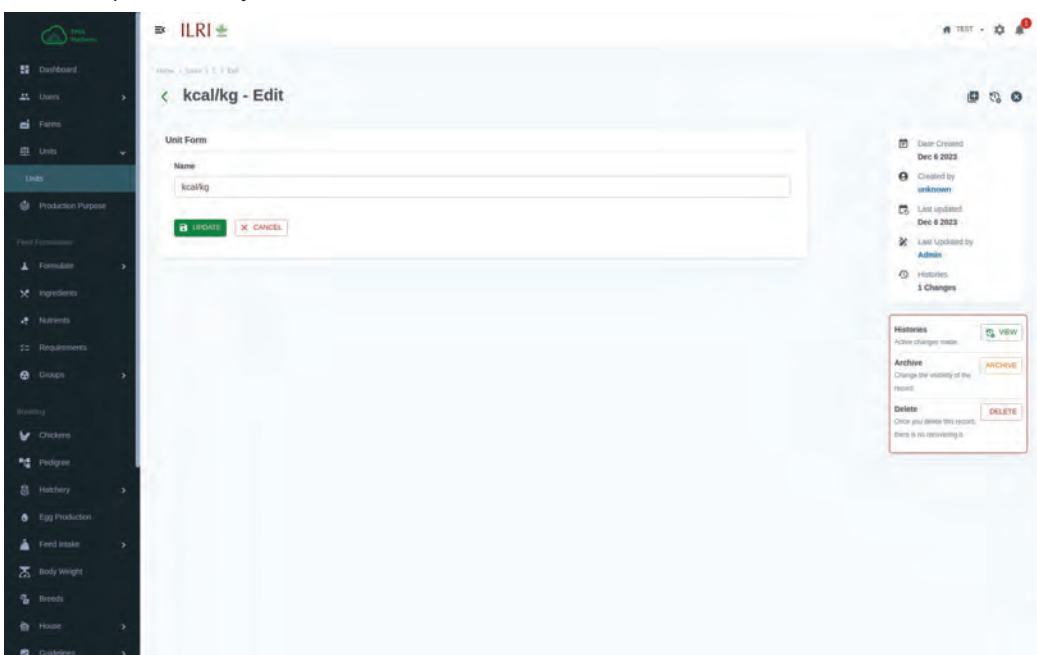


Figure 14: Edit unit.

17 Nutrient groups

17.1 View nutrient group list

1. Expand 'Group' menu and click on '**Nutrient Group**'

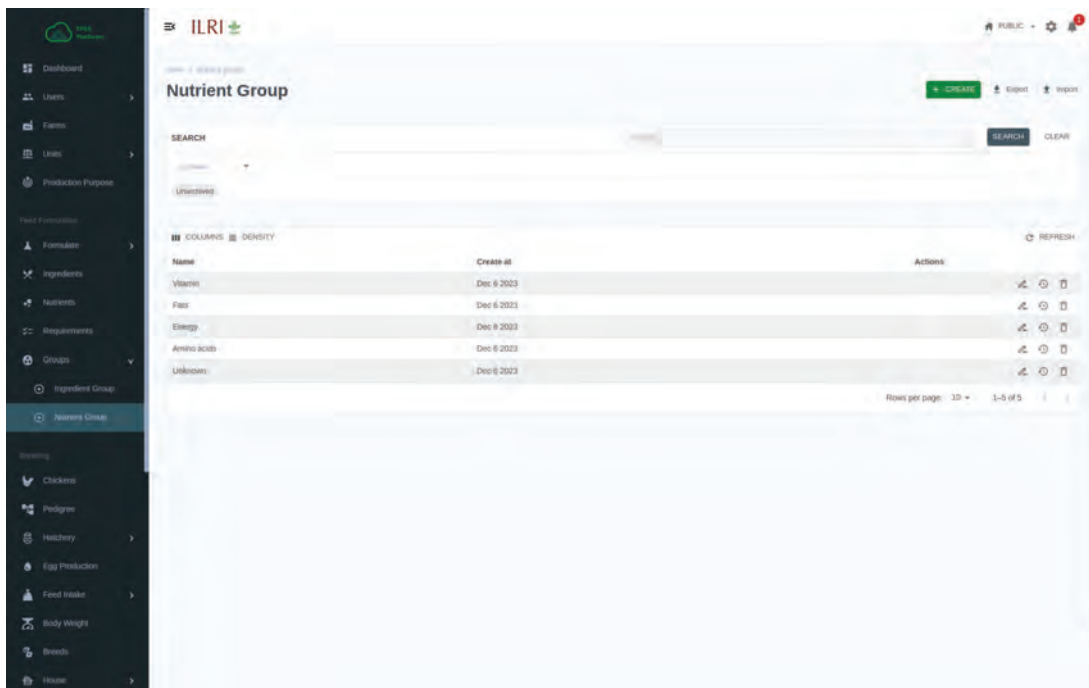


Figure 15: Nutrient group list.

17.2 Archive records

1. On filter section filter the records by archive.

17.3 Create new nutrient group

1. To create new nutrient group click on '**Create**' Refer from nutrient list Figure 16 And click '**CREATE**', you will be redirect to Nutrient List Section 17.1.

17.4 Edit nutrient group

1. Go to the Nutrient Group Refer to Section 17.1, then click on Pencil icon and it will redirect to the Figure 19.

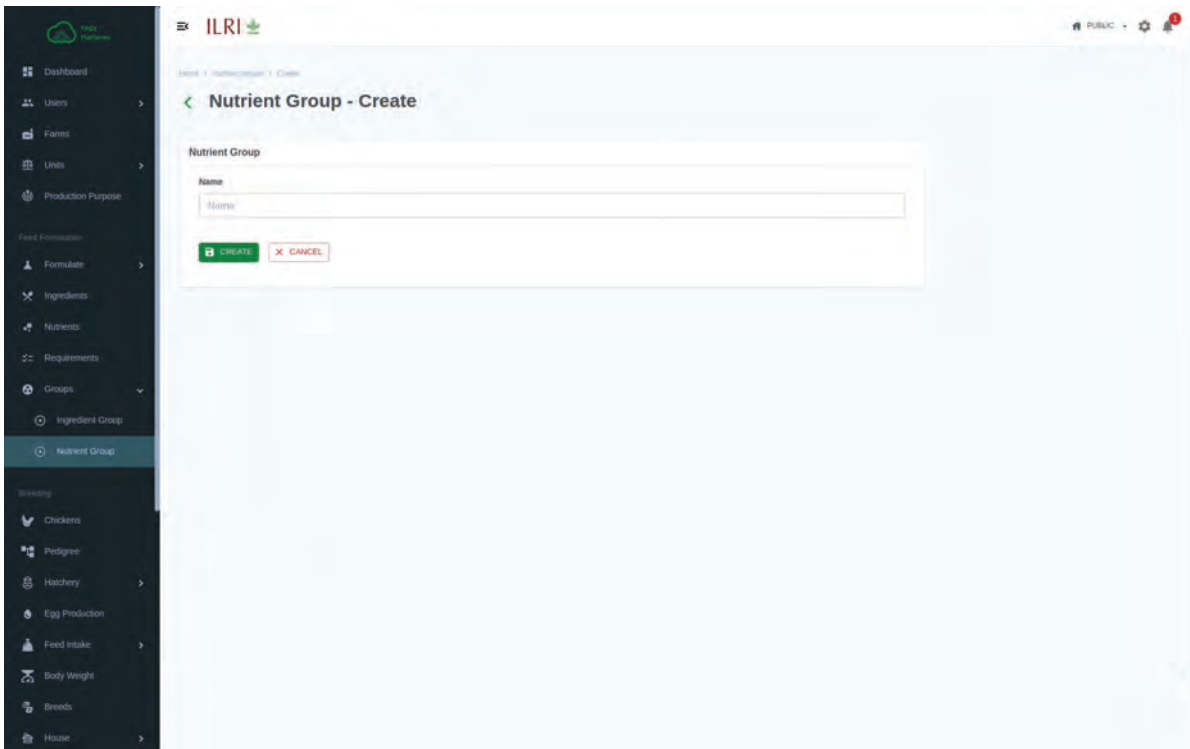


Figure 16: Create new nutrient group.

17.5 Delete nutrient group

1. Go to the edit nutrient group refer to Section 17.4.
2. To archive the record, click on **'Archive'**. If you want to bring back the record/unarchive follow the step under Section 17.2 and click on **'Unarchive'**.
3. To permanently delete the record, click on **'Delete'**.

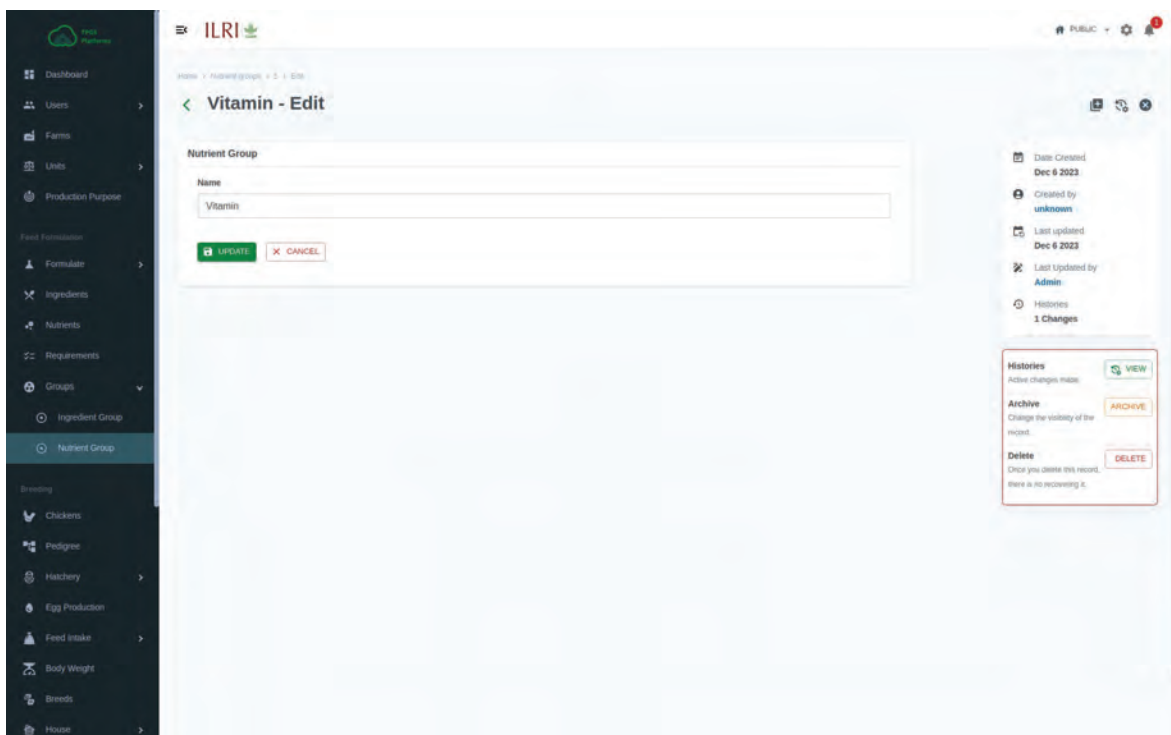
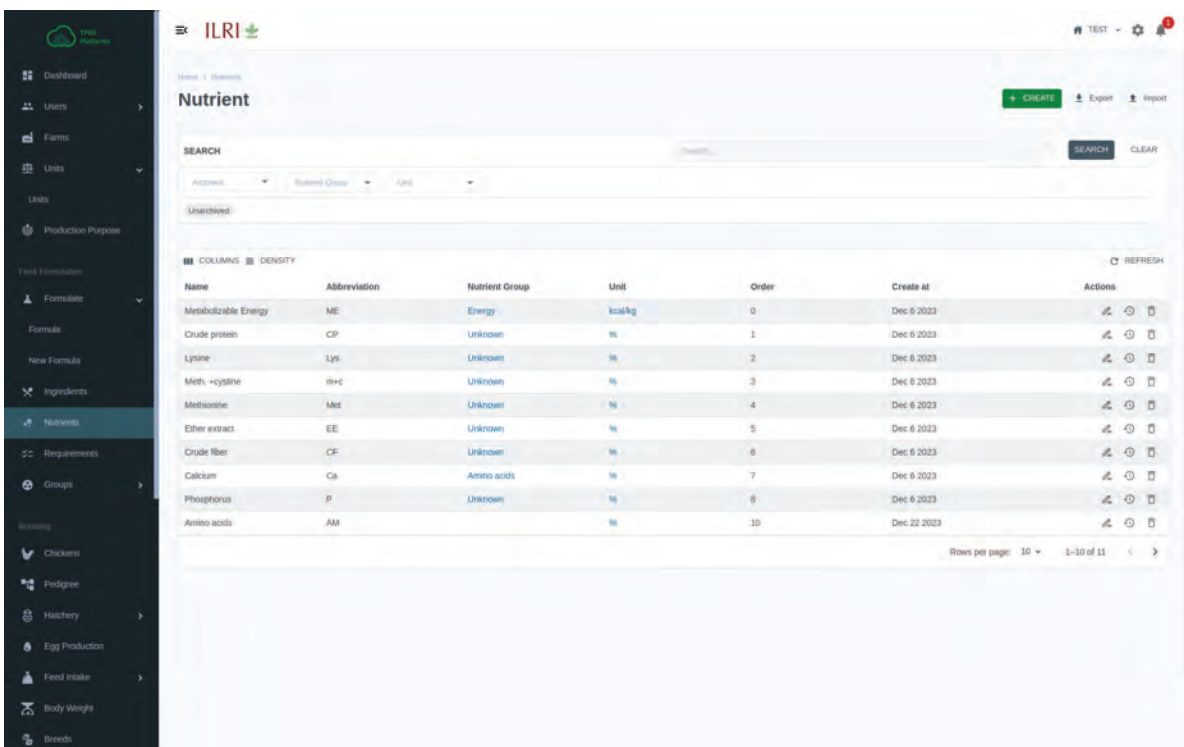


Figure 17: Edit nutrient group.

18 Nutrient

18.1 View nutrient list

1. Expand 'Group' menu and click on 'Nutrient'.



The screenshot displays the 'Nutrient' list in the ILRI application. The interface features a dark sidebar menu on the left with various navigation options. The main content area has a top navigation bar with the ILRI logo and a search bar. Below the search bar, there is a table of nutrients with columns for Name, Abbreviation, Nutrient Group, Unit, Order, Create At, and Actions. The table lists 10 nutrients, including Metabolizable Energy, Crude protein, Lysine, Meth. +cystine, Methionine, Ether extract, Crude fiber, Calcium, Phosphorus, and Amino acids. Each row includes a 'Create At' date and a set of action icons (edit, delete, refresh).

Name	Abbreviation	Nutrient Group	Unit	Order	Create At	Actions
Metabolizable Energy	ME	Energy	kcal/kg	0	Dec 6 2023	✎ 🗑️ 🔄
Crude protein	CP	Unknown	%	1	Dec 6 2023	✎ 🗑️ 🔄
Lysine	Lys	Unknown	%	2	Dec 6 2023	✎ 🗑️ 🔄
Meth. +cystine	Met+C	Unknown	%	3	Dec 6 2023	✎ 🗑️ 🔄
Methionine	Met	Unknown	%	4	Dec 6 2023	✎ 🗑️ 🔄
Ether extract	EE	Unknown	%	5	Dec 6 2023	✎ 🗑️ 🔄
Crude fiber	CF	Unknown	%	6	Dec 6 2023	✎ 🗑️ 🔄
Calcium	Ca	Amino acids	%	7	Dec 6 2023	✎ 🗑️ 🔄
Phosphorus	P	Unknown	%	8	Dec 6 2023	✎ 🗑️ 🔄
Amino acids	AM		%	10	Dec 22 2023	✎ 🗑️ 🔄

Figure 18: Nutrient list.

18.2 Archive records

1. On filter section filter the records by archive.

18.3 Create new nutrient

1. To create new nutrient group click on '**Create**' refer from nutrient list Figure 20 and click '**CREATE**', you will be redirect to Nutrient List Section 18.1.

18.4 Edit nutrient

1. Go to the Nutrient Refer to Section 18.1, then click on pencil icon and it will redirect to the Figure 23.

The screenshot shows the 'Nutrient Form - Create' page. The form includes the following fields:

- Name:** Input field with the value 'Protein'.
- Abbreviation:** Input field with the value 'Abbreviation'.
- Nutrient Group:** Dropdown menu with a plus icon.
- Unit:** Dropdown menu with a plus icon.
- Description:** Input field with the value 'Description'.
- Order:** Input field with the value 'Order'.

At the bottom of the form, there are two buttons: a green 'CREATE' button and a red 'CANCEL' button.

Figure 19: Create new nutrient form.

18.5 Delete nutrient

1. Go to the edit Nutrient Refer to Section 18.4.
2. To archive the record, click on '**Archive**'. If you want to bring back the record/unarchive follow the step under Section 18.2 and click on '**Unarchive**'
3. To permanently delete the record, click on '**Delete**'.

The screenshot shows the 'ME (kcal/kg) - Edit' page. The form includes the following fields:

- Name:** Input field with the value 'Metabolizable Energy'.
- Abbreviation:** Input field with the value 'ME'.
- Nutrient Group:** Dropdown menu with the value 'Energy'.
- Unit:** Dropdown menu with the value 'kcal/kg'.
- Description:** Input field with the value 'Description'.
- Order:** Input field with the value '0'.

At the bottom of the form, there are two buttons: a green 'CREATE' button and a red 'CANCEL' button.

On the right side, there is a sidebar with the following information:

- Date Created:** Dec 6 2023
- Created by:** unknown
- Last updated:** Dec 6 2023
- Last Updated by:** Admin
- History:** 1 Changes

Below this information is a 'Histories' section with a 'VIEW' button and three action buttons: 'Archive', 'Unarchive', and 'Delete'.

Figure 20: Edit nutrient page.

19 Contact info

For further information contact:

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20 Further reading

- Emmert, J.L. and Baker, D.H. 1997. Use of the ideal protein concept for precision formulation of amino acid levels in broiler diets. *Journal of Applied Poultry Research* 6(4):462–470.
- Leeson, S. and Summers, J. 2005. Commercial poultry nutrition. Third Edition, Nottingham University Press, Nottingham.
- Leeson, S. and Summers, J.D. 2001. Nutrition of the chicken: University books, Guelph. Ontario, Canada.
- McDowell, L.R. 2000. Vitamins in animal and human nutrition, 2nd Edition, ISBN: 978-0-813-82630-1.
- National Research Council. 1994. Nutrient requirements of poultry: Ninth Revised Edition, 1994. Washington, DC: The National Academies Press. <https://doi.org/10.17226/2114>.
- Pardue, S. and Thaxton, J.P. 1986. Ascorbic acid in poultry: a review. *World's Poultry Science Journal* 42(2): 107–123.
- Pesti, G.M., Bakalli, R.I., Driver, J.P., Atencio, A. and Foster, E.H. 2005. Poultry nutrition and feeding. Trafford Publishing.
- Ravindran, V. and Blair, R. 1991. Feed resources for poultry production in Asia and the Pacific region. I. Energy sources. *World's Poultry Science Journal* 47(3): 213–231.
- Underwood, E. 1999. *The mineral nutrition of livestock*. CAB International.

ISBN: 92-9146-846-0



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