REPUBLIC OF KENYA

KALRO
Kenya Agricultural & Livestock Research Organization

NAVCDP
NATIONAL AGRICULTURAL VALUE CHAIN DEVELOPMENT PROJECT

FEED FORMULATION METHODS FOR DAIRY CATTLE RATIONS

Introduction

Home-made rations are formulated from affordable, locally available feed resources. After identifying the most cost-effective feed ingredients that meet the nutrient needs of dairy animals, the next step involves blending these feeds to minimize cost and enhance the ration's nutrient composition.

Various methods exist for determining the appropriate mixing quantities. Some of these methods include:

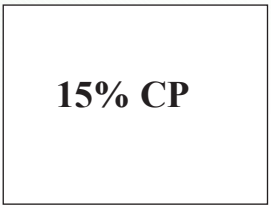
1. Pearson's Square

Pearson's Square is a simple graphical method that helps farmers achieve precise nutrient rations in feed blends, ideal for smaller-scale operations or basic formulations. It requires no complex calculations or specialized software. To use it effectively, one feed should exceed the desired nutrient level while the other is below the desired. This method only allows balancing a ration for a single nutrient at a time using two feed ingredients within one Pearson's square. When more ingredients are involved, more than one Pearson's square is used.

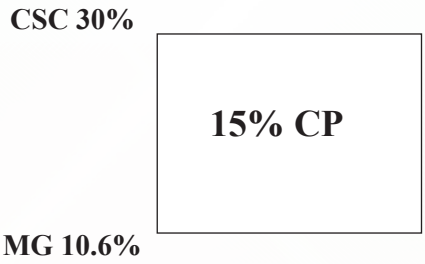
Example

Calculate the proportion needed to make a 15% CP feed mix. The feed ingredient we have available is Cotton seed cake (CSC) at 35% protein and Maize germ (MG) at 10.6% protein.

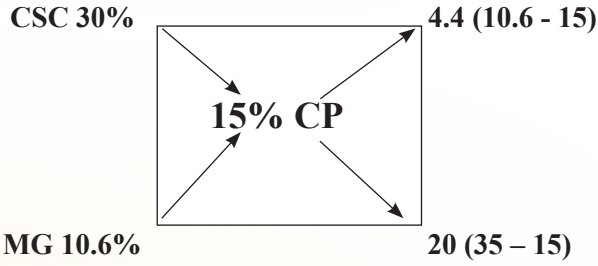
Step 1: Draw a square and insert the desired crude protein (15%) in the middle of the square.



Step 2: Place the two grains and their respective crude protein contents on the left hand corners of the square.



Step 3: Calculate the difference between the middle value and the value on the bottom and top left hand corners of the square and place the result diagonally opposite.



These values represent the portion of each ingredient required to produce a feed mix with a CP level of 15%.

35-15=20 (Value in the bottom right corner of the square) represents parts of **MG**

10.6 -15= 4.4 (Value in the top right corner of the square) represents parts of **CSC**

NB – Always disregard the negative or positive value of the numbers

Step 4: Calculate the percentage of each feed ingredient. Add the two parts figures to give the total and calculate each feed as a percentage.

$$\text{Total parts} = \underset{(35\text{-}15 = 20)}{\text{Parts of MG}} + \underset{(\,10.6 - 15 = 4.4)}{\text{Parts of CSC}}$$

$$= 20 + 4.4$$

$$= 24.4 \text{ Parts}$$

$$\text{Maize germ \%} = \frac{\text{(Difference of middle value and CSC value)}}{\text{The total of the two differences}} \times 100\%$$

$$= \frac{20}{24.4} \times 100\%$$

$$= 0.82 \times 100\%$$

$$= 82\%$$

$$\text{CSC \%} = \frac{\text{(Difference of middle value and MG value)}}{\text{The totals of the two differences}} \times 100\%$$

$$= \frac{4.4}{24.4} \times 100\%$$

$$= 0.18 \times 100\%$$

$$= 18\%$$

Quick confirmation of CP value

$$\textbf{MG 10.6\%} = \frac{10.6}{100} \times 82\% = 8.7\%$$

$$\textbf{CSC 35\%} = \frac{35}{100} \times 18\% = 6.3\%$$

Ingredient	**% CP contribution into the feed mix**
Maize germ (MG)	8.7
Cotton seed cake (CSC)	6.3
Total	**15%**

Tabulation of final feed mix

Ingredient	Proportion %	%CP contribution	*Cost
Maize germ (MG)	82	8.7	
Cotton seed cake (CSC)	18	6.3	
Total	100	**15%**	

From the tabulation result, a farmer can compute the cost of the feed

2. Excel spreadsheet

Despite cost constraints in commercial feed formulation software, Microsoft Excel emerges as a popular and readily available spreadsheet solution. Included with Microsoft Office at no extra cost, Excel requires minimal computer skills and offers versatility in feed formulation. Users can utilize Excel to formulate feeds through trial and error or by using the Excel spreadsheet solver.

i. **Excel spreadsheet trial and error**

The Excel spreadsheet trial and error method involves randomly combining ingredients with known nutrient compositions, making adjustments to the

ration combinations only as needed for production optimization. This approach is characterized by its reliance on past experience and lacks a specific, predetermined process, hence its name.

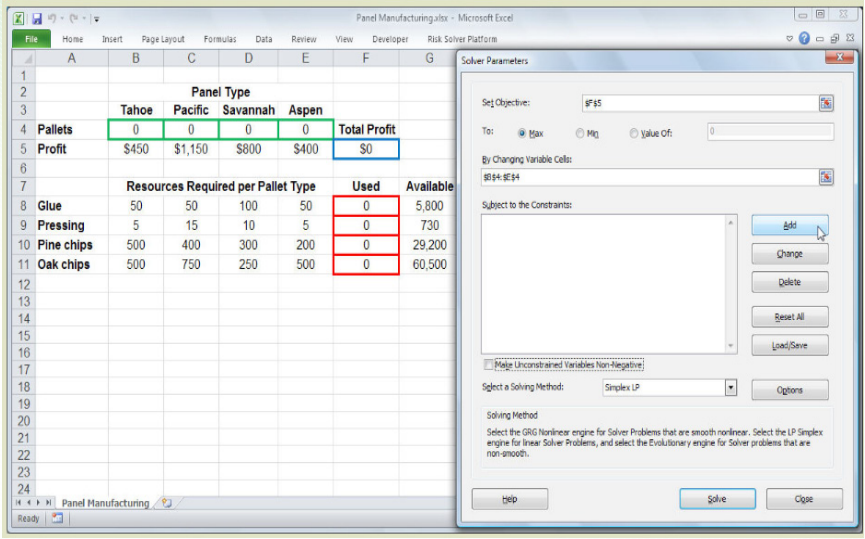
DO NOT TYPE HERE	Enter cost per kg feed (as fed)	Enter amount of feed ingredient to use in formulation of dairy feed ration	DO NOT TYPE HERE
Ingredient	Cost (KES.)	As fed (Kgs)	DM basis (Kgs)
Napier grass	2.00	-	-
Natural pastures	0.50	-	-
Natural pasture hay	1.00	-	-
Rhodes grass hay	13.00	-	-
Green maize forage	1.50	-	-
Maize silage	10.00	-	-
Maize stover	0.50	-	-
Sorghum silage	10.00	-	-
Bean Haulms	0.50	-	-
Lucerne hay	20.00	-	-
Sweet potato vines	4.00	-	-
Calliandra	4.00	-	-
Sesbania	4.00	-	-
Leucaena	4.00	-	-
Desmodium	4.00	-	-
Cottonseed cake	36.00	-	-
Sunflowerseed cake	37.00	-	-
Soyabean meal	80.00	-	-
Fish meal	120.00	-	-
Maize germ	29.00	-	-
Wheat bran	18.00	-	-
Wheat pollard	25.00	-	-
Cassava meal	10.00	-	-
Rice germ	10.00	-	-
Urea	60.00	-	-
Margic protein	200.00	-	-
Molasses	28.00	-	-
DCP	85.00	-	-
Stocklime	10.00	-	-

Calculated cost and nutrient intake of formulated dairy feed ration DO NOT TYPE HERE		Type Nutrient requirements	DO NOT TYPE HERE	
Live-weight (Kg)		400.0		
Milk yield (Kg)		20.0		
Butter fat (%)		4.0	Deviation (%)	Comments
Cost/kg	0.00	350.00	-100.0000	Correct
DM intake (Kgs)	0.00	14.00	-100.0000	Correct
ME Intake (Mj/Kg DM)	0.00	154.30	-100.0000	Reformulate!!!!
CP Intake (g/Kg DM)	0.00	2,118.00	-100.0000	Reformulate!!!!
Calcium intake (g/Kg DM)	0.00	80.00	-100.0000	Reformulate!!!!
Phosphorus intake (g/Kg DM)	0.00	51.00	-100.0000	Reformulate!!!!

DO NOT TYPE HERE		
ROUHAGE PERCENTAGE IN DAIRY FEED RATION	Roughage	Comments (Reformulate/Correc
Calculated roughage DM in dairy feed ration (%)	#DIV/0!	#DIV/0!
Minimum roughage DM in dairy feed ration (%)	40	

ii. Excel spreadsheet solver

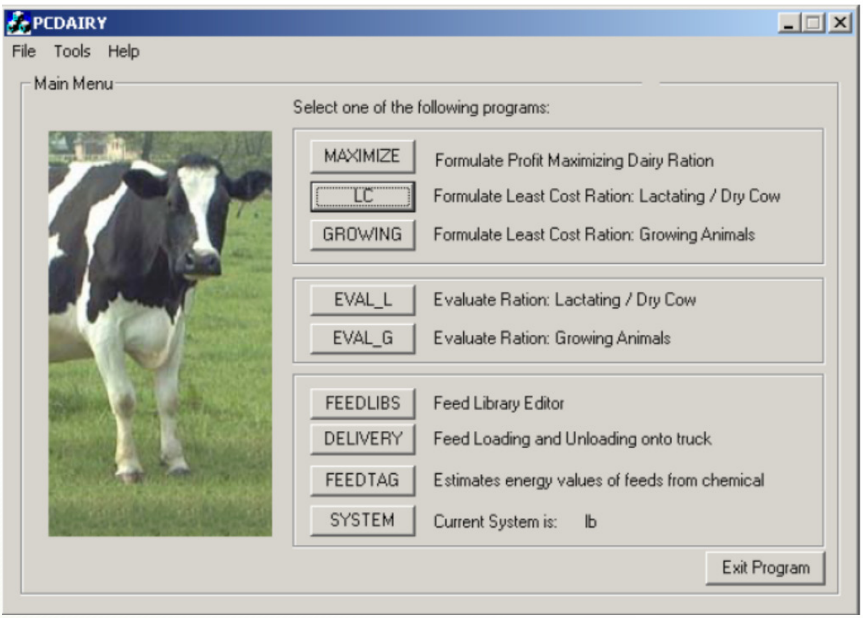
The Excel spreadsheet Solver, available in MS Excel, is a simple yet effective tool for solving linear programming problems. Linear programming optimizes a linear function with multiple variables under constraints, making it suitable for complex feed formulation challenges in larger-scale operations. Despite requiring advanced mathematical understanding and specialized software, linear programming enables farmers to create precise feed formulations tailored to their specific needs. The complexity of the model, determined by the number of decision variables and constraints, influences the difficulty of finding an optimal solution.



3. PC Dairy Software

The PC Dairy Software provides programs for formulating and analyzing rations tailored to dairy cattle. Compatible with personal computer running Windows 95, 98, 2000, and XP, users can select either least cost or maximum profit basis for ration formulation. Input parameters include target animal performance, constraints, and feed selection from a library. Outputs include rations based on cost or profit, along with their physical and chemical composition, and associated costs.

Least-Cost Formulation and linear programming are essential for farms aiming to balance cost efficiency with nutritional quality. Utilizing mathematical optimization, least-cost formulation determines the most economical combination of ingredients that meet animals' nutritional needs, ultimately enhancing dairy farm profitability.



Choosing a feed formulation method

When choosing a feed formulation method for your farm, consider factors like your operation's scale, feed requirements complexity, and resource availability. Whether you favour Pearson's Square, least-cost formulation, or linear programming, each offers unique benefits suited to different farming contexts. Equipping yourself and your team with the required skills and resources is essential to maximize your chosen method's potential. Investing in training and utilizing specialized software and tools can streamline the process, enhance accuracy, and improve overall farm performance.

Take home message

Improving feed formulation is essential in today's farming, as it directly affects animal health, productivity, and overall dairy farm profits. By choosing the right formulation method, you can effectively meet the nutritional needs of your livestock and increase dairy farm productivity. Embrace innovation, invest in learning, and customize feed formulations for best outcomes.

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