Alternative Feed Rations for Grower Stage Backyard Swine

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Abstract

In the Philippines, backyard swine raisers try to find alternative swine feed ingredients which are cheap and locally available. In formulating swine ration, feeds must contain adequate amount of energy, protein, vitamins and minerals. Unlike commercial feeds, locally available feed ingredients do not guarantee optimal nutrient content. This study aims to come up with a feed formulation that is economically cheaper while meeting the required nutrients of swine. To achieve the goals of the study, a survey has been conducted to determine the alternative feed ingredients commonly used by backyard swine-raisers. Various combinations of these feed ingredients are then considered and the corresponding mathematical programming formulations of these combinations are solved in order to come up with cheaper feed rations while meeting the required nutrients for each formulation.

Keywords: backyard swine-raising, grower stage, feed ration, mathematical programming

1. Introduction

Swine raising is a very popular enterprise in almost every rural household in the Philippines such that there is a proliferation of backyard producers which dominates the swine industry (Bureau of Agricultural Statistics (BAS), 2011). It is also one of the fastest growing business consisting of large and small scale commercial and backyard swine raisers. Aside from providing raisers with an alternative source of income, swine-raising also has the potential of giving high profits in a relatively short period of time. According to the BAS (2011), there are 13.4 million estimated pigs, commercially and backyard raised, nationwide as of January 1, 2010 with 845,511 heads in Region 10 alone. Due to this, there is a growing

competition among swine raisers which requires them to produce a better quality of pork meat than their competitors.

In producing healthy and better quality swine, raisers must first have sufficient knowledge about swine-raising. They must consider the environmental conditions of the swine and most especially, they need to invest in the food that the swine eat. They have the option to utilize commercial or other alternative local feeds. Commercial feeds assure utmost quality in regards to the nutrient requirements needed by the pigs. However, commercial feeds are expensive; hence provide less profit for the swine-raisers. The Philippine livestock sector is beset with problems of high cost and insufficient supply of quality feed ingredients (PCCARD, 2000). Feed constitute more than 80% of the total cost of livestock production. It is important therefore that much attention be given to feeds and the methods by which it could be produced through least. Bassam (2009) uses Linear Programming (LP) technique to formulate least-cost rations for broilers. In his study, both local feedstuffs and commercially-available ingredients were considered in the formulation. The paper of Zgajnar & Kavcic (2008), on the other hand, uses goal programming technique in their formulation of least-cost feed ration for bulls.

Feed formulation is one of the basic needs of animal yield industries. Performance and development of animal is directly dependent on its diet intake (Saxena, 2011). To meet the animal's requirement at a particular stage of production, it is very important to formulate the diet efficiently. Formulation of ration, the food taken by an animal on a daily basis, is concerned with combining different feed ingredients in such an efficient manner that it can provide sufficient amount of energy and nutrition to animal at different stages of production. Formulation of ration is a difficult task as it should select a combination of feed ingredients that adequately meet stated nutrients and other requirements of animal (Ajayi, *et al*., 2008; Asuquo, *et al.*, 2011). The main objective of ration formulation is to achieve a specific satisfactory nutrient level of animal species at a least cost (Saxena, 2011).

According to the Department of Agriculture (2011), many local swine raisers resort to using alternative feeds as substitute for the commercial feeds in order to cut cost production. Cassava, sweet potato ("kamote"), wild sweet potato leaves ("kamote tops"), water spinach ("kangkong"), taro ("gabi") and corn are some of the alternative feed ingredients which are locally found and are readily available in the surroundings and in the market. These alternative feeds are less expensive, however, it is most likely that they do not have

sufficient nutrient content thus resulting in a higher tendency for the swine to be smaller or have more fat. Some swine raisers employ an alternating ration, mixing commercial feeds with alternative feeds to cater the nutrients needed by the swine to cut on feed cost and thus, increase profit.

Swine require a balanced diet of energy, protein, vitamins and minerals for maximum growth and production (Crafter & Morton, 2010). In order to be a successful feeder, one must balance the ration of the feeds through utilizing the feeds which are most readily available in the community at the least possible cost. The nutritional needs of swine can be divided into six categories or classes namely water (moisture), carbohydrates, fats, proteins, vitamins and minerals. With adequate amount of nutrition from the six categories, maximum swine productivity would be ensured.

While commercial swine feeds are designed to meet swine's nutritional requirements at all stages of its growth, they are relatively expensive. To reduce the cost of swine feed, it is possible to use some alternative feeds, such as silage or sweet potatoes. However, swine have simple digestive system (similar to humans), hence they cannot utilize large amounts of forage (Saxena, 2011).

Thus there is a need to produce less expensive feeds that meet the nutrient requirements of the swine. This study focuses only on formulating an alternative feeds for grower stage backyard pigs since this is the stage where pigs grow faster and lay down lean meat faster than fat (Crafter & Morton, 2010). Also this study focuses only in the major nutrients (macro nutrients) needed by the growing backyard pigs. Moreover, this study considers 10 alternative organic feed ingredients that are locally available in Region 10. Further, this study is only focused on the formulation of feed rations based on allowable inclusion rates. The recommended rations have not been tested for palatability.

2. Methodology

2.1 Preliminaries

In order to identify alternative organic feed ingredients which are locally available, a survey among backyard swine raisers in various places in Bukidnon, Cagayan de Oro and Misamis Oriental, has been conducted.

Based on the information obtained, only the top ten feed ingredients are considered in the study. These feed ingredients are Coconut Residue (Sapal), Water Spinach (Kangkong), Sweet potato leaves (Kamote), Cassava leaves (Kamoteng kahoy), Banana pseudo stem (Bani), Duckweed fern (Azolla), Ipil-ipil leaves (Ipil-ipil), Taro leaves (Gabi), Madre de agua leaves (Madre de agua) and Water hyacinth (Water lily). Only these ingredients are considered in the formulation of the feed rations.

The survey also revealed that backyard swine raisers are not used to buying the above-mentioned feed ingredients. Instead, they gather these ingredients from their backyards and/or neighborhood. Hence, for the purposes of identifying which feed ingredients would provide for minimum total cost, the labor cost associated with the preparation of these feed ingredients are considered. The cost of labor is calculated using the following formula:

$$\textit{Labor Cost} = \textit{(Maximum Preparation Hour) X (Number of Worker/s) X (Labor Rate per Hour)} \quad (1)$$

In (1), standard preparation hour is obtained by dividing 1 hour over the number of kilogram/s produced per hour. The labor rate per hour is fixed at Php 33.3, based on the Department of Labor and Employment (DOLE) minimum wage rate per hour for employees and workers belonging to the agricultural sector. The time required to prepare the alternative feed ingredients and the corresponding cost (per kilogram), obtained during the survey conducted, are shown in Table 1.

In the formulation of the swine feeds, the nutrient content of each ingredient are carefully considered and the suggested maximum inclusion rates must be strictly followed. The nutrient contents and the maximum inclusion rates for each feed ingredient as well as the reasons for such limitations are shown in Table 2. The maximum inclusion rate corresponds to the maximum allowable amount, in terms of percentage, of a particular ingredient that can be included in a ration. Failure to follow this inclusion rate may adversely affect the health of the swine.

This study only considers the grower stage of swine since swine grow faster and lay down lean meat faster than fat during this stage (Crafter & Morton, 2010). The maximum and minimum nutrient recommendations for grower stage backyard swine are shown in Table 3.

Table 1. Time required preparing the alternative feed ingredients and their corresponding estimated costs

Feed Ingredient	Preparation Activity	Maximum Preparation Time/kilo (minutes)	Estimated Price/ Kilogram (in Php)
Sapal	Manual grating of the coconut meat and extraction of coconut milk	30	16.65
Kangkong	Harvesting & chopping; But may also be fed directly after harvesting	20	11.00
Kamote	Harvesting & chopping; But may also be fed directly after harvesting	20	11.00
Kamoteng kahoy	Harvesting & chopping; But may also be fed directly after harvesting	20	11.00
Bani	Harvesting and chopping the stem into pieces, then boiling the chopped pieces for a few minutes and draining	30	16.65
Azolla	Harvesting from the pond and draining	15	8.30
Ipil-ipil	Harvesting	15	8.30
Gabi	Harvesting, chopping the leaves into pieces, then boiling for a few minutes and draining	30	16.65
Madre de Agua	Harvesting	15	8.30
Water Lily	Harvesting, chopping the leaves into pieces, then boiling for a few minutes and draining	30	16.65

2.2 Linear Programming Model for Swine Feed Formulation

This study aims to come up with a swine feed formulation that meets the necessary nutrient requirements of grower stage backyard swine at a minimum cost. In the linear programming (LP) formulation that follows, the objective function Z is the sum of the product of the costs of the various alternative feed ingredients considered in this study, namely, sapal, kangkong, kamote, kamoteng kahoy, bani, azolla, ipil-ipil, gabi, madre de agua and water lily, and their respective quantities.

Table 2. Nutrient contents and maximum inclusion rates for the different feed ingredients.

Feed Ingredient	Basic Nutrient						Maximum Inclusion Rates (%)	Reasons for limitations
	Crude Protein, D (%)	Crude Fiber, E (%)	Crude Fat, F (%)	Calcium, G (%)	Moisture, H (%)	Phosphorus, J (%)		
Sapal	5.1	31.9	38.3	0.6	4.8	0.6	40	Fiber, palatability, poor protein quality
Kangkong	28	12	3.8	1.24	5.32	0.41	-	-
Kamote	19.4	10.2	3.07	1.79	4.97	0.24	50	Low protein
Kamoteng kahoy	14.7	10.7	0.8	0.84	10	0.76	40	Presence of cyanogenicglucosides
Bani	12.3	20.5	0.5	1.16	5	0.01	-	-
Azolla	24	9.1	3.3	0.4	14	0.9	-	-
Ipil-ipil	27.8	10.4	4.4	0.54	10	0.29	10	Toxicity(mimosine), fiber, low energy
Gabi	7.67	20	3	2	14	0.8	80	Presence of Calcium Oxalate
Madre de Agua	18.21	12.5	2.66	5	11.56	0.41	-	-
Water Lily	21.6	17.1	2.1	1.6	10.5	0.5	-	Fiber, digestibility

*Source: Institute of Animal Science, UPLB (PCARRD-DOST, 2000)

Table 3. Nutrient contents and maximum inclusion rates for the different feed ingredients

Nutrient Density (%)	Recommended Percentage of Complete Diet for Growing Pigs 20-50 kg Live Weight	
	Minimum	Maximum
Crude Protein	0.16	--
Crude Fiber	--	0.15
Crude Fat	0.04	--
Calcium	0.0085	--
Moisture	--	0.10
Phosphorus	0.005	--

Source: Institute of Animal Science, UPLB (PCARRD-DOST, 2000)

$$\min \quad Z = \sum_{i=1}^{n} c_i x_i$$

subject to

$$\sum_{i=1}^{n} x_i \leq 2 \text{ kg} \qquad (2)$$

$$\sum_{i=1}^{n} D_i x_i \geq 0.32 \text{ kg} \qquad (3)$$

$$\sum_{i=1}^{n} E_i x_i \leq 0.30 \text{ kg} \qquad (4)$$

$$\sum_{i=1}^{n} F_i x_i \geq 0.08 \text{ kg} \qquad (5)$$

$$\sum_{i=1}^{n} G_i x_i \geq 0.017 \text{ kg} \qquad (6)$$

$$\sum_{i=1}^{n} H_i x_i \leq 0.20 \text{ kg} \qquad (7)$$

$$\sum_{i=1}^{n} J_i x_i \geq 0.01 \text{ kg} \qquad (8)$$

$$x_i \geq 0 \text{ for } i = 1,2,\cdots,10 \qquad (9)$$

In this LP formulation, we denote by x_i $(i = 1,2,\cdots,n)$ the quantity (in kilogram, kg) of feed ingredient *i* used in the feed formulation, where *n* is the

number of feed ingredients considered in the feed formulation. The costs for each feed ingredient (as shown in Table 1) is denoted by c_i while D_i, E_i, F_i, G_i, H_i, J_i correspond, respectively, to the nutrient content of each of the feed ingredient, found in Table 2. The values on the right hand side of the LP model above corresponds to the nutrient recommendations based on Table 3. Inequality (2) above specifies that the total feed formulation must not exceed 2 kilograms, the maximum intake per feeding for each grower stage backyard swine. The nutrient requirements are reflected in inequalities (3) – (8) while inequality (9) ensures that the quantities (in kg) of feed ingredients used in the feed formulation are nonnegative.

3. Results and Discussion

This study considers the various combinations of the ten (10) feed ingredients taken 3 (4, 5, 6, 7, 8, 9, or 10 at a time) in order to come up with feed rations for grower stage backyard swine. LP models are formulated by considering each possible combination and then solving the resulting LP models using the excel solver. Seventy-seven (77) possible rations have been obtained. The thirty (30) least-cost alternative feed rations, its composition and corresponding costs are shown in Table . Figure 1 shows a histogram representation of the amount of the ingredients used in each of the 30 rations.

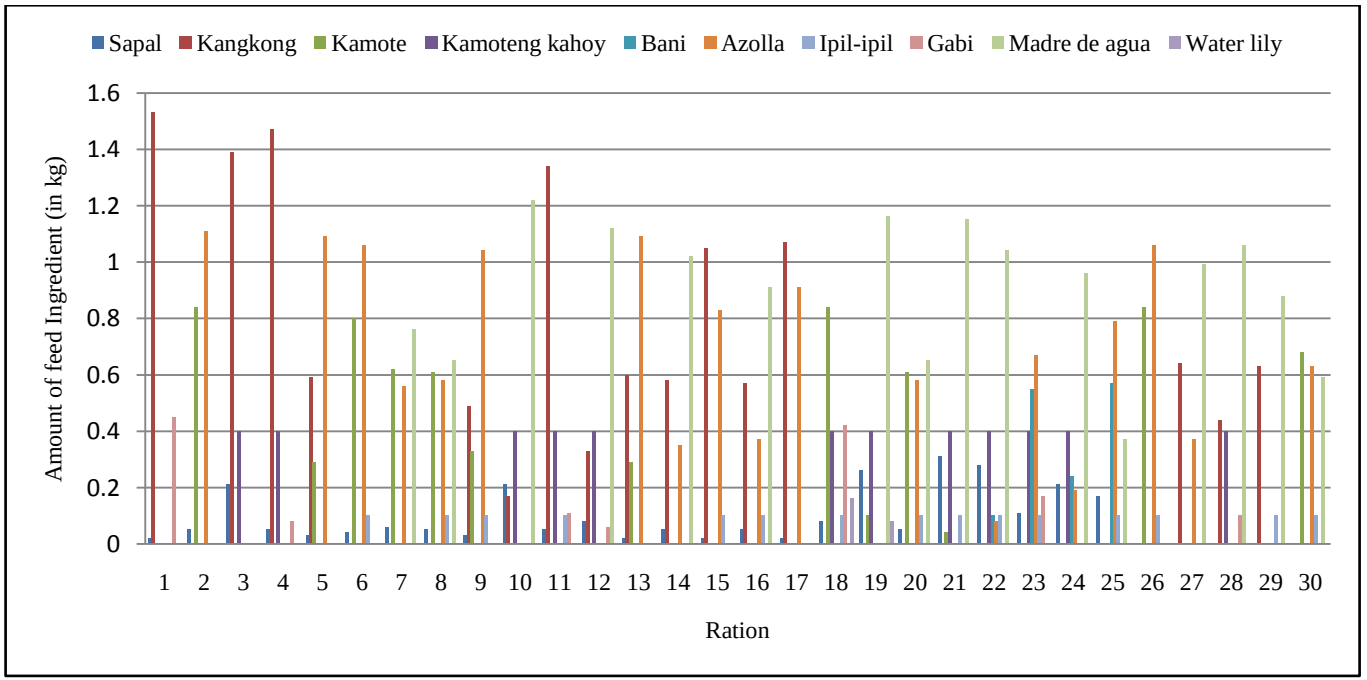
It can be seen from Table 4 that ration 29 is the cheapest ration, which costs Php 9.15 per kilo while ration 18, at Php 12.73, is the most expensive ration among the 30 feasible least-cost rations. The cheapest ration contains 3 ingredients namely, sapal, kamote, and madre de agua, while the expensive ration contains 6 ingredients namely, sapal, kamote, kamoteng kahoy, ipil-ipil, gabi and water lily. Twenty-five of the 30 rations include sapal in its ingredients. This may be attributed to its higher crude fat content as compared to the other 10 feed ingredients considered. Note, however, that sapal is one of the most expensive ingredients considered in this study. It is similarly priced as bani, gabi and water lily. Bani and water lily are the least used ingredients. This may be due to the low crude fat content of these two ingredients.

The nutrient contents of the 30 least-cost alternative feed rations are shown in Figure 1. It can be observed that all 30 rations satisfy the recommended

Table 4. Amount of feed ingredient used for the 30 least-cost alternative feed rations for grower stage backyard swine and the corresponding costs.

RATIONS	Ingredients										
	Sapal	Kangkong	Kamote	Kamoteng Kahoy	Bani	Azolla	Ipil-Ipil	Gabi	Madre de Agua	Water Lily	Cost per kilo (in Php)
1	0.02	1.53						0.45			12.34
2	0.05		0.84			1.11					9.62
3	0.21	1.39		0.40							11.59
4	0.05	1.47		0.40				0.08			11.36
5	0.03	0.59	0.29			1.09					9.62
6	0.04		0.80	0		1.06	0.10				9.55
7	0.06		0.62	0		0.56			0.76		9.38
8	0.05		0.61			0.58	0.10		0.65		9.35
9	0.03	0.49	0.33		0	1.04	0.10				9.55
10	0.21	0.17	0	0.40	0				1.22		9.95
11	0.05	1.34	0	0.40			0.10	0.11			11.31
12	0.08	0.33	0	0.40				0.06	1.12		9.90
13	0.02	0.60	0.29		0	1.09		0			9.62
14	0.05	0.58			0	0.35			1.02		9.30
15	0.02	1.05		0	0	0.83	0.10	0			9.81
16	0.05	0.57		0	0	0.37	0.10		0.91		9.26
17	0.02	1.07		0	0	0.91		0		0	9.84
18	0.08		0.84	0.40	0		0.10	0.42		0.16	12.73
19	0.26		0.10	0.40	0			0	1.16	0.08	10.40
20	0.05		0.61	0		0.58	0.10	0	0.65		9.35
21	0.31		0.04	0.40			0.10	0	1.15	0	10.19
22	0.28			0.40	0.10	0.08	0.10	0	1.04		10.42
23	0.11			0.40	0.55	0.67	0.10	0.17		0	12.31
24	0.21			0.40	0.24	0.19		0	0.96	0	10.70
25	0.17				0.57	0.79	0.10	0	0.37	0	11.39
26	0	0	0.84	0	0	1.06	0.10	0		0	9.44
27	0	0.64	0	0	0	0.37		0	0.99	0	9.17
28	0	0.44	0	0.40	0		0	0.10	1.06	0	9.86
29	0	0.63		0	0	0	0.10	0	0.88	0	9.15
30	0		0.68	0	0	0.63	0.10	0.00	0.59	0	9.22

Figure 1. Amount of feed ingredient used for the 30 least-cost alternative feed rations for grower stage backyard swine.



nutrients for grower stage backyard swine as shown in Table 4. It can be seen from Figure 2 that the cheapest feed ration has lower crude fiber and crude fat content as compared to the most expensive ration. However, it has a higher crude protein, calcium and moisture content than ration 18. Moreover, if kangkong, kamote and madre de agua are used as ingredients in a ration, their contribution (in terms of quantity) to the overall ration is higher as compared to the other ingredients considered. If kamoteng kahoy and ipil-ipil are used as ingredients in a ration, their contribution in the total ration is equal to their maximum dietary inclusion level, which is 0.4 and 0.1, respectively.

4. Conclusion and Recommendation

This study presents alternative feed rations for grower stage backyard swine utilizing feed ingredients which are available in the swine raisers backyard and their neighborhood. Based on the results of this study, swine raisers are given the chance to minimize the cost spent on swine feeds while ensuring that the required nutrients for the proper growth of the swine are met. It should be noted that costs of feed rations obtained in this study are nearly half the price cheaper than most commercial feeds available in the market at present.

To further improve this study, it is recommended that an actual feeding experiment be conducted by swine raisers in order to check for the palatability of the recommended optimal rations.

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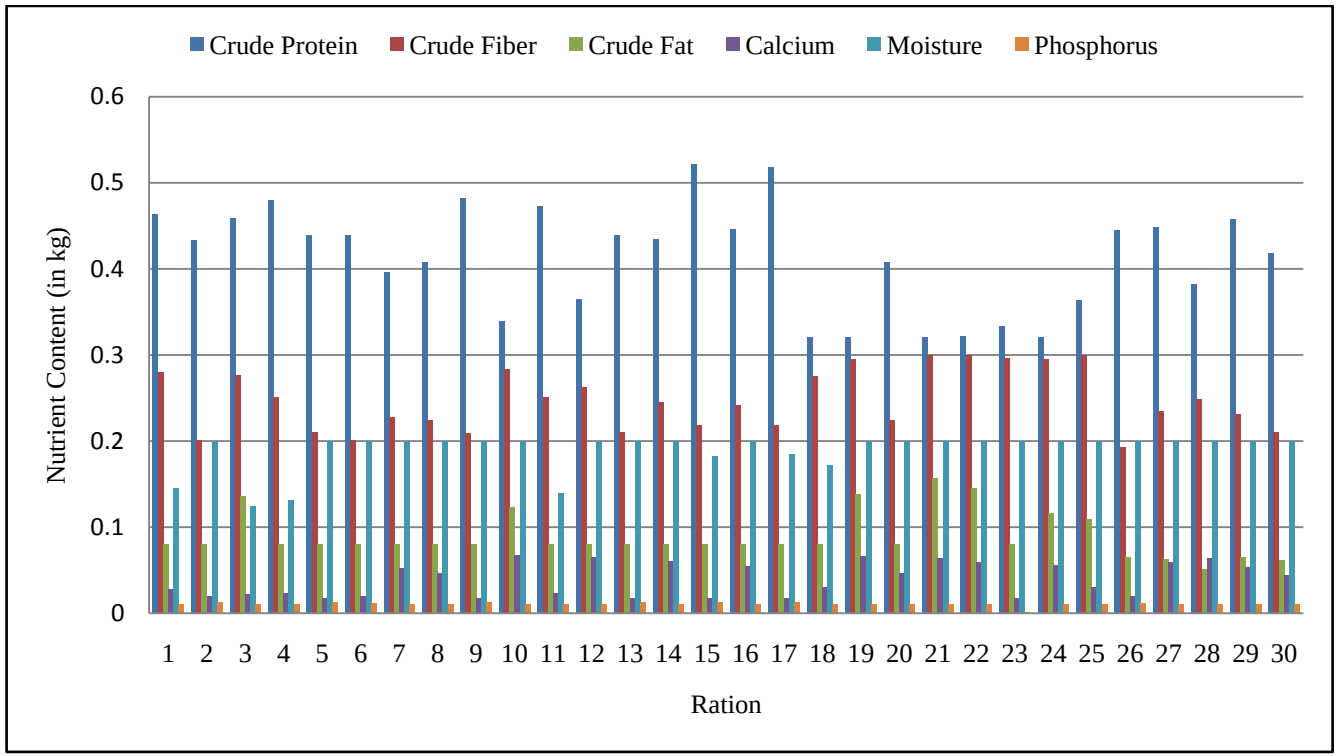

Figure 2. Nutrient content of the 30 least-cost alternative feed rations for grower stage backyard swine.

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