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Cassava as an Ideal Replacement for Maize in Poultry Feed to Improve the Income of Smallholder Farmers

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Abstract
Cassava is one of the staple food crops grown in sub-Saharan Africa. The crop offers numerous opportunities for profit gains from sales to various value chains including for human food and livestock feed. Cassava utilization in poultry feeds is well documented in other parts of the world including Asia and West Africa but has not been taken to scale in Southern and Eastern Africa. In this study we assessed the benefits of selling cassava roots to poultry feed manufacturers and poultry farmers as a replacement for expensive maize meal to determine the effects of cassava inclusion as source of energy on prices of poultry feeds in Malawi and Tanzania. Healthy cassava roots and those partially affected by cassava brown streak disease were used in the study as source of carbohydrates for poultry feed. Results showed that cassava farmers made additional 27% and 36% profits in Malawi and Tanzania, respectively, by selling fresh cassava roots to poultry value chain as compared to selling for human food. In addition, poultry farmers made an extra 24.1% profit using cassava-based feeds due to reduced disease and mortality rate and fast growth of chicks compared to using maize based feeds. Cassava has the added advantage of saving on transportation as it is readily available locally, thus promoting local trade and business. There is great potential for using cassava in poultry feeds to improve the incomes of farmers.

Key words: Smallholder farmers, cassava feed, poultry feed

Introduction

Cassava is one of the staple food crops grown in sub-Saharan Africa. It is an extremely drought-tolerant crop that can grow with minimal rainfall and thrive in soils and conditions when most other crops fail. This makes cassava a key food security crop in Africa especially suited for areas of high climate variability. Cassava also offers opportunities for income generation for farmers from the sale of fresh cassava roots and diverse processed products. Lately cassava has been given priority by policymakers as one of the strategic crops because of its fast expansion as cash and staple food crop. It is grown by resource marginalized smallholder farmers to satisfy nutritional needs and for additional income spent on food and children's education (Forsythe et al., 2016). Its versatile nature gives the crop virtual advantages to spur the livelihood of smallholders who are mostly women farmers. The crop offers numerous opportunities for profits gains from sales as food for humans (Guira et al. 2017), bakery ingredients (Malimi et al. 2018), livestock feeds (Bokanga 1995), poultry feeds (Aboud et al. 2017) and cassava peel silage (Kusmartono et al. 2022). Expanding cassava utilization in feed industry creates additional market opportunities to drive demand for fresh cassava roots. Despite the numerous advantages provided by the crop, cassava is affected by viral diseases such as cassava brown streak disease (CBSD) and cassava mosaic disease (CMD) which affect root quality and yield (Bamidele and Amole 2021). The spread of CBSD across eastern and southern Africa since 2004 has caused an estimated loss up to 70% from susceptible cassava varieties due to loss of quality (Alicai et al. 2019). Farmers have attempted to minimize losses due to CBSD infected roots by processing them for inclusion in poultry feeds (Aboud et al. 2017; Kasankala et al. 2019).

Utilization of cassava in poultry feeds is well documented in other parts of the world especially in Asia and West Africa. However, this technology has never been taken to scale in Southern and Eastern Africa. Knowledge on energy utilization for growth performance in poultry and effect on feeding cost for raising chickens is critical in assessing the economic potential for inclusion of cassava in chicken feeds. Data on cassava energy utilization for chicken's growth performance is available (Anaeto and Adighibe 2011; Aboud et al. 2017). However, feeding costs information from cassava inclusion in poultry feed is limited. This study was undertaken to assess the benefits to cassava producers of selling cassava roots to poultry feed manufacturers and poultry farmers, and to determine the effects of cassava inclusion as source of energy on prices of poultry feeds in Malawi and Tanzania.

2.0 Materials and Methods

The study took a two-pronged approach to assess the economic feasibility of using cassava as source of energy in poultry feeds in the two study countries. Clean roots and those affected by CBSD were used in the study as source of carbohydrates in poultry feeds. The initial studies were conducted in Sengerema district in Tanzania and Lilongwe district in Malawi between 2015 and 2017. Misenani Agro vet, a company dealing with hatchery of broilers and layers, offering veterinary services and manufacturing animal feeds participated in the trial in Tanzania. Ndatani Premiers feeds, a manufacturer of assorted animal feeds including for poultry participated in Malawi. A variety of value chain actors participated including cassava farmers, processors and poultry farmers from 6 districts (Biharamulo, Sengerema, Ilemera, Mwanza city, Kwimba, Bunda and Musoma Municipal in Mwanza, Kagera and Mara regions) in Tanzania and 3 districts (Mulanje, Lilongwe and Nkhotakota) in Malawi.

2.1 Feed Formulations and Study Locations

The linear programming technique (LP) (Al-Deseit 2009) was used to determine the best possible combination of nonconventional available productive resources such cassava in Tanzania. Cassava was added to poultry feeds and the nutritive values of the ingredient used for diet formulation as described by (Aboud et al. 2017). In brief, cassava used in feed formulation was divided into three classes based on the level of damage caused by CBSD, with class I cassava having no signs of disease in the root, class II having up to 5% damage, and class III having damage ranging from 5 to 10% of the storage root, because class II and class III in this study did not differ significantly, they were combined and reported as affected cassava. The comparison of costs of feeds formulated using LP model by comparing the costs of feeds made from clean cassava and that of the affected cassava. Three diets were formulated from each class at 12.05%, 24.1% and 36.15% to make a total of 48.2% of carbohydrate of the feed formulated and a control was prepared in the same manner but without cassava. This LP model (Al-Deseit 2009) was adopted to formulate the least cost feed to meet the nutritional requirement of the birds with the assumption that the constraints and objective functions are linear equations representing straight lines.

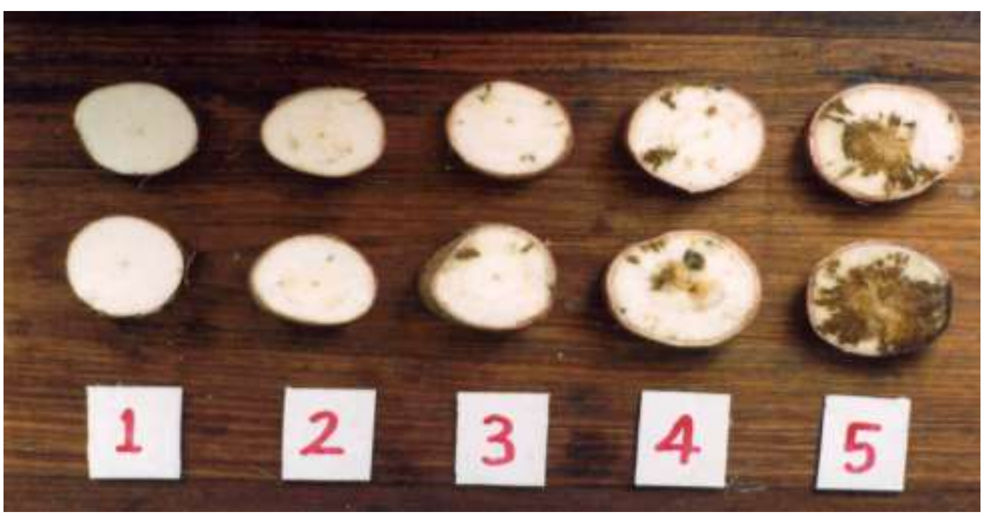
The study used clean cassava roots and processed through grating to get dry grits at processing locations in Malawi. The grits were incorporated into a range of poultry feeds including broiler starter, growers mash and broiler finisher. Cassava inclusion was at 24% in broiler starter and 44% in growers' mash and broiler finisher respectively. The feed was pelletized and fed to chicken in pellets form for seven weeks. Two batches of 200 chicks each were used in the study one feeding on feeds where cassava was incorporated and the other on the traditional maize based feeds as control. Day old chicks were fed from feed rations containing cassava and the other feed from maize as source of carbohydrates. The trial was replicated in three batches to confirm the findings. Data was collected on cost of production of the feeds, observation on health condition of the chicks, death rate of chicks within the first three weeks and carcass weight of market-ready chicken starting at six weeks.

Following positive results from initial studies, the cassava-based feed was demonstrated to poultry farmers through the National Poultry Association in Malawi. Two smallholder poultry farmers were identified and selected to participate in commercial feed demonstration using cassava-based feeds from Chitsime and Chiwamba Extension Planning Areas (EPAs) in Lilongwe district. The National Poultry Association provided list of farmers to participate in the commercial trials using cassava-based feeds. The criteria for selecting farmers were that the poultry farmers should have been familiar with feeds from the feed manufacturer (Ndatani Premier Feeds) and that they were willing to document and share experiences with other farmers among others. Two farmers were trained and supported to use cassava-based feeds within their own communities. Observations on the growth of chicks and anomalies that could arise from use of the newly formulated feed were recorded. Records of dates of the first sales of the chicken were also made. Field days were conducted for poultry farmers from surrounding areas and those from other districts with support from the National Poultry Association.

3.0 Results and Discussion

3.1 Least cost Formulation

This section describes the estimated least cost feed obtained by using LP model. Three models were used whereby in model 1 no cassava was included, model 2 contained healthy cassava and model 3 contained CBS- affected cassava (class II and Class III). Significant differences ($P<0.05$) were recorded on the cost of feed where healthy cassava was used as compared to CBSD-affected cassava (Tables 1 and 2). Class IV and V were not included in the study due to its severity (Figure 1). In previous study (Aboud et al. 2017), reported no significant differences in the crude protein content ($P > 0.05$) between healthy cassava (3.09%) and affected cassava class II (2.98%) and class III (3.09%), which are within the range of 2-5 % reported for cassava and peels (Kusmartono et al. 2022; Retnaningrum et al. 2021). Considering cassava has less protein than maize, the amount of soy cake in the feed was increased from 15% for feeds without cassava to 20% for feeds with cassava to compensate for the protein loss (Table 1).



1 = No symptoms, 2 = less than 5% root necrosis, 3 = 5-10% root necrosis, 4 = 10-50% root necrosis, 5 = More than 50% root necrosis

Figure 1. CBSD root severity scoring scale.

Table 1: Maize feed with and without cassava ingredients estimates from LP model

Variables	Variable estimates from LP model		
	Without cassava	With healthy cassava	With affected Cassava
Maize, X1 (kg)	0.45289	0.24100	0.24100
Cassava, X2 (kg)	0.00000	0.24000	0.24000
Soy cake, X3 (kg)	0.15000	0.20000	0.20000
Sunflower cake, X4 (kg)	0.10000	0.10000	0.10000
Maize bran, X5 (kg)	0.11115	0.03300	0.03300
Fish meal, X6 (kg)	0.18000	0.18000	0.18000
Salt, X7 kg)	0.00300	0.00300	0.00300
Premix, X8 (kg)	0.00300	0.00300	0.00300
Minimum cost (USD)	0.305	0.304	0.294

The cost of feed formulated without cassava inclusion was 0.305 USD per kilogram while the cost of feed formulated with inclusion of healthy cassava roots was 0.304 USD and 0.294 USD for CBSD affected cassava (Table 1). The slight cost differences between diets without and with cassava were caused by an increase in soy cake which is very expensive. The permissive level of cassava in feed without affecting the costs of feed by the LP model was 24% in one kilogram of feed formulated (Table 1), contributing 49.9% of the total energy in the feed. This is in line with what was reported by (Ngiki 2014) that cassava root meal can be included up to 50% and 60% in broilers and layers feed rations to replace maize respectively.

The linear programming model revealed a slight cost of feeding chickens with maize based feed as compared to cassava based feed. In fact, because maize was more expensive than cassava, the addition of soy cake increased the cost of cassava-based diets. Maize prices typically escalate in urban and deficit markets even though may decrease during harvesting period in rural areas (Wahab et al. 2022; Net 2018). Both maize and cassava are staple foods, but maize is the most consumed and of major source of energy for consumers. Maize also forms a key input in animal feed for caloric energy which creates competition between human and livestock needs (Aboud et al. 2017). The costs variation between feeds made from healthy and affected cassava was due to price difference.

Effects of market prices of cassava on costs of feed

This section elucidates the price levels of cassava at which its inclusion into maize feed could not cause a detrimental effect on cost using the LP model. Results revealed an increased feed cost with the increased price of cassava. At price 0.132042 USD and above was not economical to include cassava in feed formulation (Table 2).

Table 2: Costs of broiler feeds (1kg) at different price levels of cassava (LP Model)

When price per kg of cassava (USD)	Price of feeds without cassava (USD)	Price of feeds with cassava (USD)
0.066021	0.305	0.293943
0.088028	0.305	0.299225
0.110035	0.305	0.304506
0.132042	0.305	0.309788
0.154049	0.305	0.314722
0.176056	0.305	0.319128
0.198063	0.305	0.323538

3.2 Benefits of selling fresh cassava roots to poultry feed value chain

This section provides information regarding the actual field as experienced by farmers between 2018 and 2021. Farmers in Tanzania sold dried cassava for poultry feed production at US$107.60 per ton, whereas the same quantity was sold for human use at $78.73 (Table 3). The same trend was recorded in Malawi where farmers sold dried cassava for poultry feed production at $111.17 per ton as compared to $79.49 for the same quantity when sold for human consumption. Farmers made additional income of USD 21.5 and 29.0 which were equivalent to 27% and 36% per ton of dried product in Malawi and Tanzania by selling fresh dried cassava to poultry value chain respectively. The study in Tanzania showed that cassava roots affected by CBSD for class II and class III were usable for poultry feeds. CBSD affects quality of roots, which makes them not usable for human consumption. The results therefore provided an alternative to farmers who would otherwise lose the entire crop by giving them an option to make money by selling to poultry feed producers.

Table 3: Benefits of selling 1 ton of fresh cassava roots for poultry feed versus human food in Malawi and Tanzania (USD)

Descriptions	Tanzania		Malawi	
	Human food (USD)	Poultry feed (USD)	Human food (USD)	Price for poultry feed (USD)
Price for 1 ton (Dried cassava)	78.73	107.73	79.49	111.17
Labour charge for harvesting 1 ton	0	0	0	6
Labour charge for collecting roots to one location	0	0	0	4
Total additional costs	0	0	0	10
Net income to farmer	78.73	107.73	79.49	101
Additional income for selling to poultry feed	-	29	-	21.5

Key: 0 implies that the charges were paid for by the buyer.

Maize is the dominant ingredient in the production of poultry feed as source of carbohydrates in Tanzania and Malawi. The study confirmed opportunities for using cassava as partial replacement of maize in the poultry feed manufacturing as source of energy. Value chain actors such as cassava farmers as well as poultry farmers highlighted number of benefits. The first benefit for cassava farmers was the availability of market opportunities presented by the poultry feed value chain. This allowed farmers to sell cassava in large volumes per unit time. This motivated them to start selling cassava using conventional units such as kilogram (kg) and ton as opposed to other forms. Fresh cassava roots are mostly sold using a variety of unit measurements including field, bag, heap and per root. The opening up of new market opportunities in poultry industry motivated farmers to work together in groups for easy access to yield improving technologies such as improved planting materials, appropriate crop husbandry practices in-order to improve productivity and processing and market information. Farmers started getting organized into stable marketing units for participation in cassava marketing.

3.3 Benefits of using cassava-based feed to poultry farmers

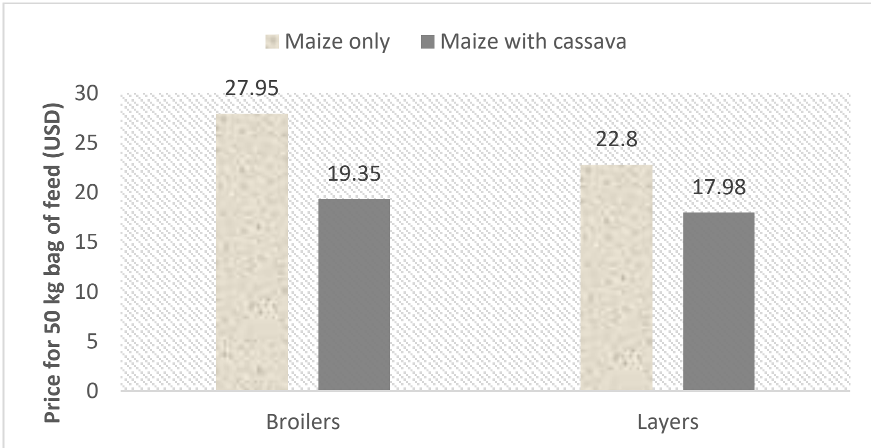


Figure 2. Price of 50 kg bag of maize feeds with and without cassava

Figure 3. Examples of poultry chick trials that included feeding them with cassava-based feeds

The study demonstrated that poultry farmers also benefitted from incorporation of cassava in poultry feeds. Examples of the setting of feeding trials of chicks are shown in Figure 2. The cost of feed where cassava was incorporated as source of carbohydrates was 19.35 USD per 50 kg bag compared to the cost 27.95 USD per 50 kg bag for broiler maize feed without cassava. While costs of a 50 kg bag for layers' maize feed with cassava was 17.98 USD against 22.80 USD for maize feed alone without cassava (Figure 2). Therefore, poultry farmers using feed where cassava is incorporated are more likely to pay $8.60 and $4.82 less for a 50 kg bag of broiler and layers feed, respectively. This represents cost reduction of 30.8% for broiler feeds and 21.1% for layers.

Poultry farmers recorded additional benefits associated with using cassava-based feeds compared to feeds where maize was the sole source of energy. These benefits included reduction in mortality rate of chicks, at 1.5% for cassava-based feeds compared to 2.5% mortality for maize-based feeds (Table 4). Farmers also recorded less incidence of diseases in cassava-based feeds as compared to those fed on maize based feeds. Furthermore, chicken fed with cassava-based feeds matured 12 days earlier than those fed from maize based feed (Table 4). These observations were significant for poultry farmers as they would translate to increased incomes. Reduced mortality rate would mean selling more chickens on the market and thereby increased profit margins. Feed is the main variable input in broiler production (reference); therefore reducing maturity period by 12 days meant that feed was saved for that period and contributes to profit margins for poultry farmers. Feed cost being the prime input in commercial poultry production determines the survival and profitability (Aboud et al. 2017). As stated by Emmanuel et al., (n.d.), managing energy intake would decrease cost and improve quality to generate profit. Results of the study showed that poultry farmers using feeds where cassava was incorporated made 24.1% additional profit as compared to using maize based feeds (Table 4). Poultry farmers are often faced with high cost of feed due to escalating prices of raw materials especially soy, sunflower, fish and maize. Results of this study provide an opportunity for farmers to increase profits for their investment and remain in business.

Table 4: Benefits of using cassava-based feeds for poultry farmers

Parameter	Maize feed	Cassava feed
Starting stock (starting number of chicks)	1000	1000
Remaining chicks discounting those that died due to various reasons	975	985
Total income for poultry farmer @ $5.2/ bird	$5148.8	$5201.6
Cost of extra maize feed for 12 additional days @ 2.34 bags per day	$956.0	0
Net income for farmer	$4192.7	$5201.6
Cost saved	-	$1007.5
% additional profit	-	24.1

4.0 Conclusions

Cassava offers a great opportunity for both producers and poultry farmers to increase profitability if incorporated in feeds as a source of carbohydrates. Notable benefits to producers include opening up of new market opportunities in the poultry value chain, motivating farmers to participate in profitable value chain and increasing profit margins. Poultry farmers will also benefit increasing profit margins through reduced disease incidence and mortality rate and fast growth of the chicks. The use of cassava in chicken feeds also provides an opportunity for farmers especially in high CBSD areas to have alternative market for their produce. As feed prices continue to soar, cassava offers an opportunity to keep poultry farmers in business. Cassava is an important crop for food security as it is resilient to climate shocks. There is need for a cohesive and robust awareness campaign amongst value chain actors to adopt the new technologies.

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