Agricultural Sciences, 2023, 14, 1561-1572
https://www.scirp.org/journal/as
ISSN Online: 2156-8561
ISSN Print: 2156-8553

Utilisation of Non-Conventional Animal Waste as Feeds by Multiple Livestock Species Farmers in Lake Victoria Crescent of Central Uganda

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How to cite this paper: Kabugo, S., Okello, S., Nalule, S.A. and Kahwa, D. (2023) Utilisation of Non-Conventional Animal Waste as Feeds by Multiple Livestock Species Farmers in Lake Victoria Crescent of Central Uganda. *Agricultural Sciences*, **14**, 1561-1572.
https://doi.org/10.4236/as.2023.1411101

Received: October 8, 2023
Accepted: November 18, 2023
Published: November 21, 2023

Abstract

A cross-sectional survey was conducted to establish the utilisation of non-conventional animal waste in multiple livestock species systems. Farmers (150) were selected from four out of ten districts of Central Uganda in Lake Victoria Crescent. A structured questionnaire was used and descriptive analysis showed that over 80% are smallholder farmers on <1.0 Ha of land practice mixed livestock combinations. Farmers (16%) are shifting to integrated livestock species combinations with the acquisition of faming experience (>3.0) years. Household husbands (80%) significantly ($P < 0.001$) influence choices of livestock and production systems. Labour is majorly family (40.7%) with house wives (63.3%) actively involved in farm operations. Farmers (86.3%) use costly conventional feeds which influence ($P < 0.001$) livestock categories and production efficiency. Farmers (16.7%) are shifting to cheaper and readily available non-conventional feeds with over 50% using swills ranked I (RI) for its availability, nutritious and cheap followed by blood (RII) and bone meal (RII). Others in RII are meat offal, fish meal, insect meal and rumen offal. In RIII are dead chicks, hatchery rejects and animal litter. In RIV are oyster shells while bio-yeast and insect-maggot-worm are in RV which are the most costly and unavailable feeds. Maggot and worm feed are cheaply cultured from poultry faeces (52%) and cattle dung (25%) for mainly fish and monogastric production. Untreated non-conventional feeds are relatively risky (RR > 1.0) as they cause poor livestock health due to pathogens, parasites and toxins which are associated (OD > 1.0) with poor growth, mortality and condemnation of livestock products. The remedy to unsafe non-conventional feeds is to apply

effective solar-heating (75%), chemical and ensiling treatment methods. The study showed that there are no significant ($P < 0.001$) public health risks associated with utilising treated non-conventional feeds instead it improves production and sustainability of multiple livestock species systems.

Keywords

Multiple Livestock Species, Non-Conventional Feed, Animal Waste, Public Health, Feed Treatment, Central Uganda

1. Introduction

The demand for animal products in Lake Victoria Crescent including Central Uganda is expected to increase beyond 70% by 2050 which requires coping strategies for sustainable livestock production systems for food security. As a matter of public concern and scientific remedy, population dynamics, climatic and ecological situation need interventional measures (Bernès *et al.*, 2011 [1]). Livestock farming demands enormous resources, feeds being the most challenging due to limited availability of feed ingredients, climatic change and food-feed-fuel competition (Makkar *et al.*, 2014 [2]). As a guiding principle, the notion "waste" refers to a misplaced resource but can still be converted into valuable livestock inputs. The potential of animal waste as non-conventional feeds could be exploited through proper processing, recovery and recycling to feed livestock (Haobijam & Souvik Ghosh, 2018 [3]). Animal waste as feeds focuses on the nutritive value, levels of feeding, environment factors such as housing and health (Müller, 1982 [4]; Flachowky, 1997 [5]). The success of livestock production system depends on the feed conversion efficiency of animal waste into feed resources (Haobijam & Souvik Ghosh, 2018 [3]). In view of minimizing the use of costly conventional feeds, animal waste feeds should be exploited to improve livestock production and sustainability (Sikka, 2006) [6]). Excretion and litter from livestock can be alternative basal feed, and substrate for culturing insects as feeds for livestock and fish (Nasiru *et al.*, 2014 [7]. Animal waste feed including entomophagy in nutrient reuse can be a remedy to costly feeds in mixed and integrated livestock systems (Van Huis *et al.*, 2015 [8]). The presence of antimicrobial drugs, pesticides, mycotoxins and hormonal residues in feeds affects animal performance (Crawshaw, 2012 [9]). The pathogen risks, and xenobiotic problems render animal waste feeds unsafe and lower animal products quality (Fink-Gremmels, 2012 [10]). Consumption of products from waste-fed animals as envisaged from the health and safety standpoint requires processing and treatment technologies. Dehydration, ensiling, chemical and mechanical treatment are some of the effective methods used to process animal waste feeds to acceptable levels (McAllister *et al.*, 2011 [11]; Chen, 2015 [12]). Composting and biodegradation of waste via insect cultures or manure could also be used as recycling processes (Acuña *et al.*,

2011 [13]; Peiretti *et al.*, 2014 [14]). Animal waste not only increases production but also is potentially useful for survival of animals during seasonal feed scarcity (Mwesigwa *et al.*, 2020 [15]). Proper processing of animal waste and nutrient balancing with other ingredients can potentially substitute 30% of conventional feeds without compromising the quality of livestock products (Tadele, 2015 [16]). Supplementation or substitution of conventional feeds with non-conventional feeds can efficiently support feasible and sustainable livestock-fish production systems (Makkar and Ankers, 2014 [17]; Komolafe and Sonaiya 2014) [18]). The survey therefore, sought to ascertain the potential and safe utilization of processed non-conventional feeds for improvement and sustainability of multiple livestock species production in Lake Victoria Crescent of Uganda.

2. Materials and Methods

2.1. Study Area

A survey focused on multiple livestock species production and fishing districts in Lake Victoria Crescent (LVC) of Uganda (LVB, 2013 [19]). The area receives total annual rainfall of 2400 mm with bimodal distribution and temperature range of 16˚C - 28.7˚C (MAAIF, 2011 [20]). LVC consists of 10 districts with potential for sustainable livestock agriculture to cater for a population of 30 million of which 60% are unemployed and live below poverty line (UBOS, 2015 [21]). A region with low livestock production due to costly conventional feeds accounts for 75% of expenses (Sikka, 2006) [6]). Livestock product consumption is still constrained by socio-cultures and public health risks among the communities (LVBC, 2007 [22]).

2.2. Data Collection

Data on utilisation non-conventional feeds in multiple livestock species farmers was collected from 150 selected respondents for a period of three months from four districts of Buikwe, Kayunga, Mukono and Wakiso representing LVC of Central Uganda. The respondents were multiple livestock farmers rearing more than two livestock on the same farm and adopting animal waste feed resources in diets of animals and fish. Guided interview with a structured questionnaire was used to collect data as described by Broom, (2005) [23] and Gill *et al.*, 2005 [24]).

2.3. Data Analysis

Data was coded and entered into the SPSS computer software (IBM SPSS statistics 20). Qualitative information gathered during the study was quantified and subjected to descriptive statistics at $P < 0.05$ in form of percentages. Chi-square (X^2) test was used to identify the most significant difference in risk factors associated with utilization of non-conventional feeds by multiple livestock species farmers in LVC of Central Uganda.

3. Results and Discussion

3.1. Characterisation of Households

The results in Table 1 shows that multiple livestock species systems (MLS) farmers (84%) practice predominantly mixed species combinations while 16% integrated species with inclusion of fish. MLS farmers (80%) in LVC are smallholders with less than one hectare of land (LVBC, 2007 [22]). Livestock farming is male (80%) dominated by husbands but wives (20%) are involved more in farm activities. Farmers (78.8%) with experience of (>3.0) years practice MLS more sustainably. Only 17% of the farmers are using less costly non-conventional feeds and more expensive traditional feeds by 83.3% of farmers. Income from livestock by-products remain low at 30 %, while 70% of the farmers earn income mainly

Table 1. Participant's demographic characteristics and categories (n = 150) in LVC of Central Uganda.

Characteristic	Category	Frequency-n (%)
Gender of farmers		
	Males	120 (80.0)
	Female	30 (20.0)
Experience (Years)		
	<3.0	32 (21.3)
	>3.0	119 (78.7)
Land size for livestock (ha)		
	<1.0	120 (80.0)
	>1.0	30 (20.0)
Labour Provision		
	Family	61 (40.7)
	Hired	33 (22.0)
	Family and hired	56 (37.3)
Family involvement		
	Male/Husband	52 (34.7)
	Female/wife	98 (65.3)
Multiple livestock species		
	Mixed C-F-G-Pi-Po*	126 (84.0)
	Integrated C-F-G-Pi-Po	24 (16.0)
Feed		
	Conventional	125 (83.3)
	Non-conventional	25 (16.7)
Household income		
	Animal products	104 (69.3)
	By-products	46 (30.7)

* Po-Pi-G-F species combination: Ruminant (C = Cattle, G = goat/sheep), Monogastric (Pi = Pig, Po = Poultry), F = Fish.

from sale of livestock products in LVC (Acuña *et al.*, 2011 [13]; Makkar *et al.*, 2014 [2]).

3.2. Utilisation Non-Conventional Feeds in Livestock Production

The adoption and increased use of non-conventional feeds (NF) is enhanced by farmers' ability to acquire occupational practice and experience (Komolafe and Sonaiya, 2014) [18]). **Figure 1** shows that majority of the farmers (59.3%) acquire occupational practice and experience from other farmers, friendly interactions (22.2%), media and agro-companies (11.1%).

Efficient and economic use of NF should be in tandem with farming experiences and livestock performance (Smith and Wheeler, 1979 [25]). **Figure 2** shows the methods for determining the right quantities of feed to avoid feed wastage, inadequate feeding and poor growth performance of livestock. Lack of measuring equipment renders the farmers (70%) to estimation feeds. Only 25% of the farmers possess weighing scales for accurate measurement of feeds. Farmers (5%) apply trial and error or unrestricted feeding methods which cause

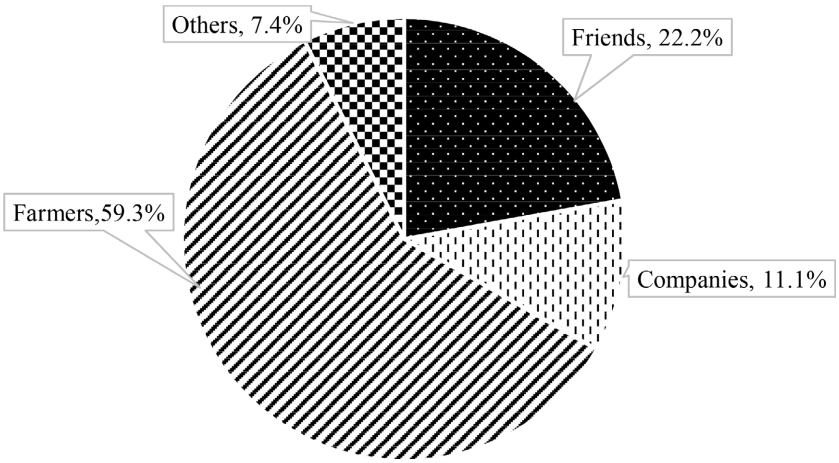

Figure 1. Sources of information on the use of non-conventional feeds.

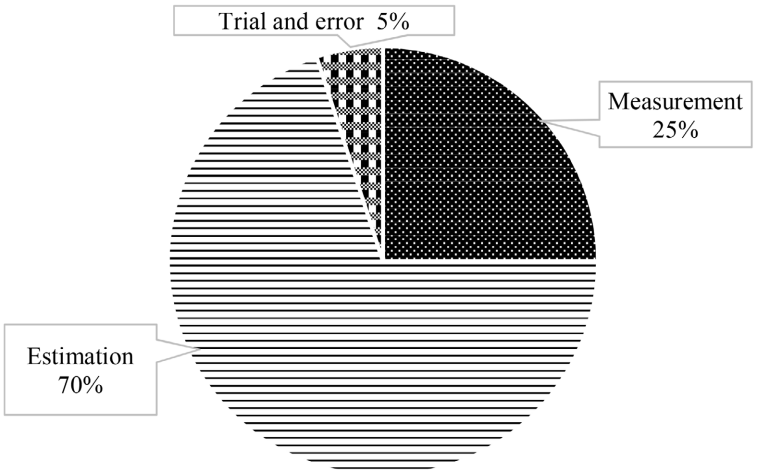

Figure 2. Methods of determining feed quanties to livestock.

feed wastage, inadequate feeding and improper growth performance of livestock (Müller, 1982 [4]).

The findings in Table 2 indicate the types of NF commonly utilised by farmers as indicated by Tadele (2015) [16] and ranking in MLS production. Swills are the highest ranked (RI) as they are readily availability, nutritious and low cost by 58% of farmers. Meat offal, fish meal, insect meal, bone, rumen offal and blood meal are in RII as most nutritious and low cost feed used by 50% of the farmers. Dead chicks, hatchery rejects, animal litter in RIII as the most available and nutritious. The most available and less costly are oyster shells in RIV. Bio-yeast and insect maggot and worm meal in RV are nutritious, not easily available and costly. Availability, cost and nutritional capacity of non-conventional feeds determine the quantities, livestock categories and systems to adopt by farmers (Makkar and Ankers, 2014 [17]).

3.3. Utilisation of Animal Waste as Substrate for Culturing Non-Conventional Feeds

Figure 3 shows the different animal waste substrates used for culturing insect worms and maggots as feeds in livestock production. Chicken faecal substrate is the most productive and used by 52% of the farmers, 25% prefer cattle dung to pig (10%) and goat or sheep dung (3%), and bio-slurry (4%) in production of worms for animal feeds. Some farmers (6 %) prefer faecal waste substrates from

Table 2. Types and ranking of non-conventional feeds utilised by farmers in LVC of Central Uganda.

Multiple livestock species farmers (n = 150)		
Nonconventional feeds	**Utilisation n (%)***	**Rank****
Food waste/swills	88 (58)	I
Blood	82 (55)	II
Bone/horn meal	79 (53)	II
Animal litter	60 (40)	III
Meaty/offal	47 (31)	II
Oyster shells	15 (10)	IV
Rumen/gut content	13 (9)	II
Dead chicks/rejects	12 (8)	III
Insect meal	12 (8)	II
Fish waste	5 (3)	II
Bio-yeast	3 (2)	V
Insects-maggot-worm meal	2 (1)	V
Egg shells	2 (1)	V

*Respondents (n) in percentage (%), **Rank: I = Available, nutritious, low cost, II = Nutritious, low cost, III = Available, nutritious, IV = Available, Low cost, V = Nutritious, unavailable and costly.

other rare species such as rabbits to produce worms as livestock feeds (Acuña *et al.*, 2011 [13]). **Figure 4(a)** indicates that livestock farmers are fast adopting to the use of less costly maggots and worms, which are cultured from different

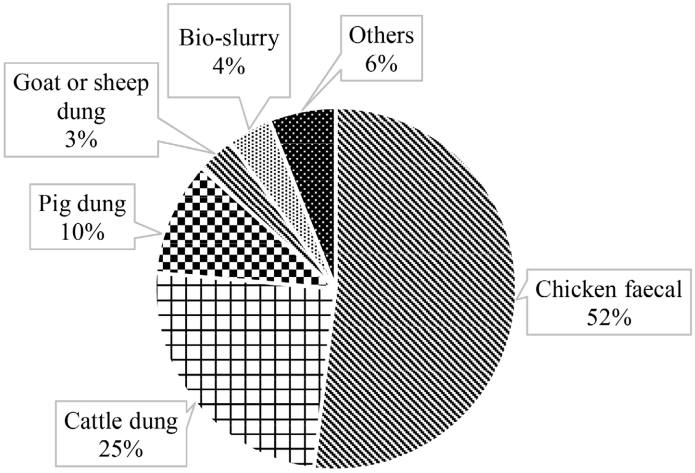

Figure 3. Types of substrates for culturing maggots-worms-insect as stock feeds.

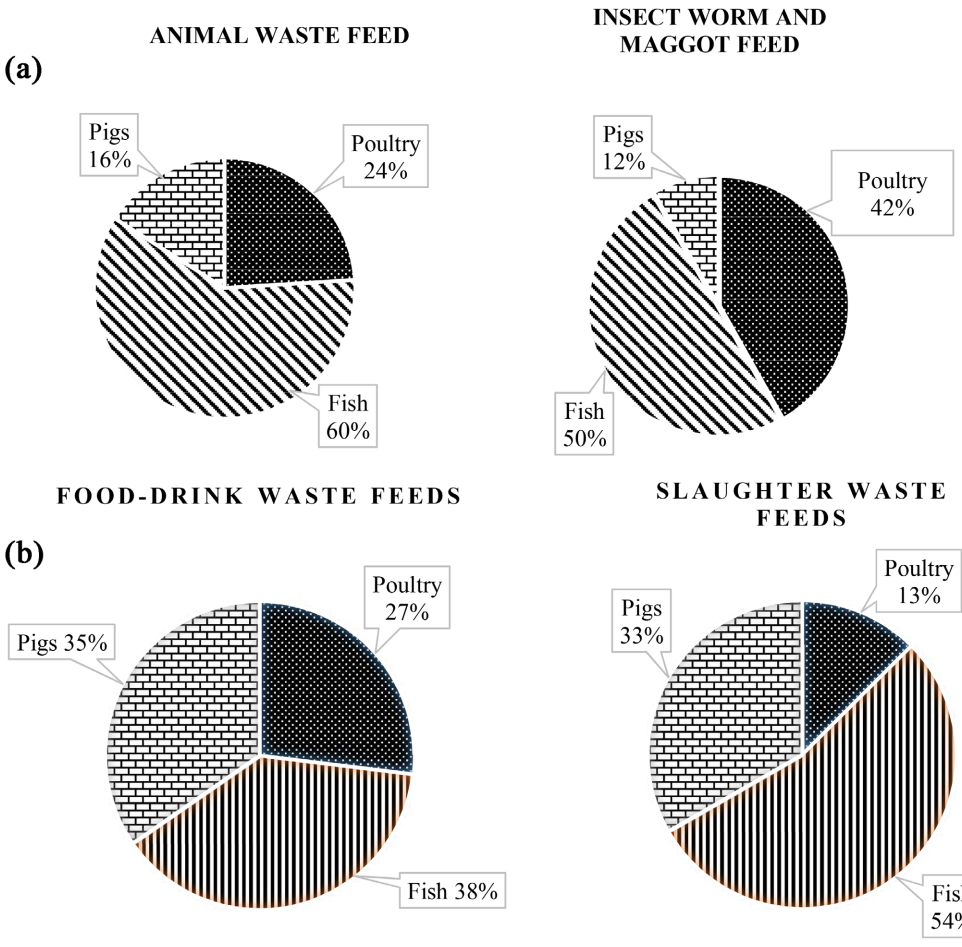

Figure 4. (a) Insects and animal waste as non-conventional feed for monogastric and fish; (b) Types of livestock fed on food-drink and slaughter waste feeds.

animal faecal substrates. The insect feeds are fed to livestock species mainly fish and monogastric, namely pigs and poultry to substitute the scarce and costly conventional feeds such as fish meal (Van Huis *et al.*, 2015 [8]).

Farmers use more of the worms and maggots as nutritious feeds for fish. Poultry and pig farmers are using the same feed resources as either supplements or substitutes for conventional feeds (Sika, 2006 [6]). Animal waste feeds from slaughter houses, hatcheries, swills and manure are being used mainly to feed fish. With more acquisition of feeding knowledge, the same feeds are being used for poultry and pigs (MacAllister *et al.*, 2011 [11]). The findings in **Figure 4(b)** indicate that about 35% of the farmers feed pigs and fish on food and drink waste while 27% feed it to poultry. Slaughter waste is mainly used as feeds for fish by 54% of respondents, pigs by 33% and only 13% feed it to poultry (Mwesigwa *et al.*, 2020 [26]). The findings from the study established that 7% of the respondents do lack or have inadequate knowledge to utilize non-conventional feeds in multiple-species livestock production (Nasiru *et al.*, 2014 [7]). The findings from the study as shown in **Figure 5** established that majority of the respondents (42%) consider feed quality as a major factor in determining the type of non-conventional feeds to utilise, 25% consider animal stage, 13% on the animal type reared and feed adequacy while 7% do lack or have in adequate knowledge for the choice of non-conventional feeds to utilise in multiple livestock species production.

3.4. Characteristic Variables of Non-Conventional Feeds on Livestock and Public Health Risks

The exposure of livestock to health risks, public health and negative social perceptions associated with the use of non-conventional feeds (NF), which affect acceptability of the consumer products are shown in **Table 3**.

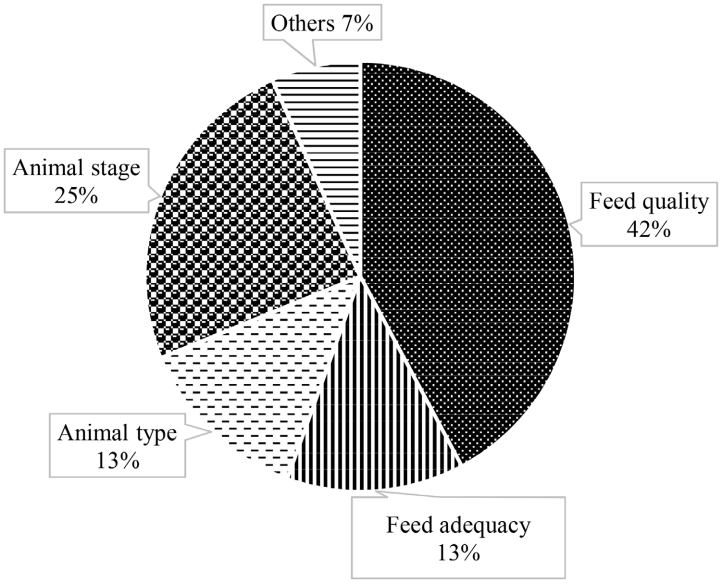

Figure 5. Major factors considered in utilising non-conventional feeds.

Table 3. Effect of non-conventional feeds on livestock and public health.

Variable	Characteristic health effects of non-conventional feeds							
	Effect n (%)	No effect n (%)	Odds of effect	Risk of effect	OR	RR	X^2	P-value*
Micro/pathogen								0.00001
Exposed	92 (61.3)	58 (38.7)	1.59	0.61	4.68	2.42	39.5837	
Not exposed	38 (25.3)	112 (74.7)	0.34	0.25				
Endo-parasites								0.00001
Exposed	84 (56)	66 (44)	1.27	0.56	3.50	2.1	26.6129	
Not exposed	40 (27)	110 (73)	0.36	0.27				
Toxins								0.00001
Exposed	85 (56.7)	65 (43.3)	1.89	0.65	7.00	3.08	36.2273	
Not exposed	34 (23.0)	116 (77.0)	0.27	0.21				
Growth								0.000053
Good	59 (39.3)	91(60.7)	0.68	0.39	0.39	0.63	16.3399	
Poor	94 (62.7)	56 (37.3)	2.59	0.59				
Mortality								0.000017
Low	65 (43.3)	85 (56.7)	0.78	0.43	0.36	0.64	18.4908	
High	102 (68.0)	48 (32.0)	2.13	0.68				
Fear/perception								0.000494
Social risk	98 (65.3)	52 (34.7)	1.88	0.65	2.27	1.44	12.1381	
Health risk	68 (45.3)	82 (54.7)	0.83	6.45				

*Significant at $P < 0.05$, OR = Odds ratio RR = Risk ratio X^2 = Chi-square statistic value.

The findings show that it is risky (RR > 1.0) to use untreated NF of animal origin due to presence of pathogens, endo-parasites and toxins. These are associated (OR > 0.1) with poor growth and mortality of livestock. NF are rejected (OR > 1.0) on basis of social perception than on associated health risk (RR > 1.0) in livestock production. There is no significant ($P < 0.001$) reason for rejection of treated NF as nonnutritive and unsafe for both livestock and public health (Fink-Gremmels, 2012 [10]). Treated NF is safe for both livestock and human health, it is a precursor for development of livestock sector (Bernès *et al.*, 2011 [1]).

3.5. Treatment and Preservation Methods of Non-Conventional Feeds

Non-conventional feeds should be treated and processed before use in order to improve their nutritional potential, increase safety and livestock product acceptability by consumers (Fink-Gremmels, 2012 [10]). The different treatment and processing methods used by some of the farmers in Lake Victoria Crescent are as shown in **Figure 6**. The use of solar treatment and processing of NF was regarded as an effective method of improving shelf life, pathogen and toxin

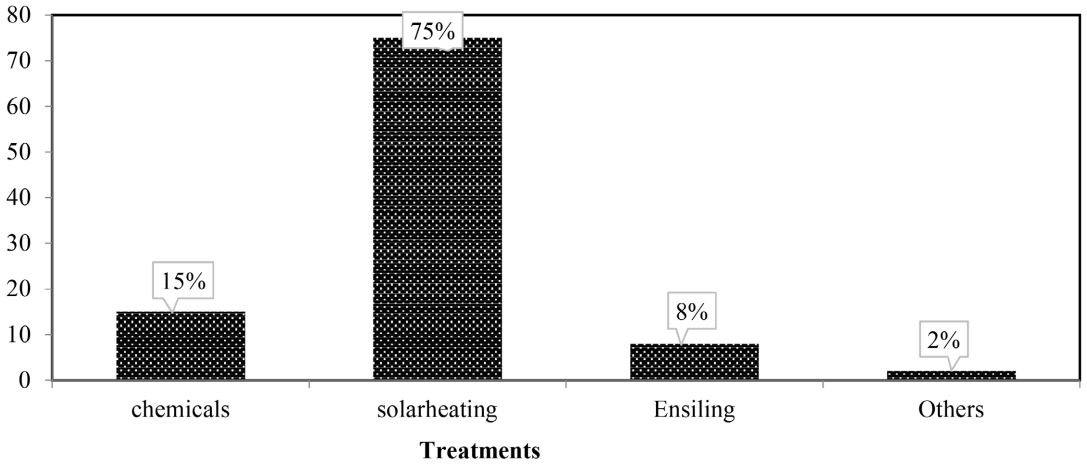

Figure 6. Treatment and processing methods of non-conventional feed materials.

control by 75% of respondents. Chemical treatment is effectively applied by 15% of respondents while 8% commend the feed ensiling treatment (Crawshaw, 2012 [9]). Other 2% apply integrated treatments in processing and preservation of feeds. Treatment during processing methods is found to reduce health risks and improve healthy safety and acceptability of consumer products (Ogello et al., 2013) [27].

4. Conclusion

The study established that there are bio-spherical and socio-economic setbacks facing multiple livestock species production in Lake Victoria Crescent. Poor and costly traditional feeds contribute greatly to low income and sustainability of livestock production. Utilisation of nutrients through recycling and non-conventional feeds of animal origin is a remedy to scarce and costly traditional feeds which cause low production. However, non-conventional feeds should be properly treated to avoid animal and public health incidences causing sickness and death. Effective treatment methods of feeds should be utilised to remove fears and negative social perception of consuming livestock products. The study emphasized safety, enhancement of consumer confidence and acceptability of livestock products. The future prospects of multiple livestock species systems lie in utilising cheap non-conventional feeds as a remedy to high cost of production and low output.

Acknowledgments

The authors are grateful for the financial support from Makerere University and Swedish International Development Agency (MAK-SIDA) in collaboration with Kyambogo University. Highly appreciate the staff of Uganda National Farmers Federation (UNFFE) of Buikwe, Kayunga, Mukono and Wakiso districts. This work is Reference: SVARREC/05/2018 and National Council for Science and Technology, NCST A9ES.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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