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Characterisation of Smallholder Multiple Livestock Species Production Systems in Parts of Lake Victoria Crescent of Central Uganda

Stephen Kabugo[1,2*], Samuel Okello[1], Sarah A. Nalule[3], David Kahwa[3]

[1]Department of Livestock and Industrial Resources, School of Veterinary Medicine and Animal Resources, College of Veterinary Medicine, Animal Resources and Biosecurity, Makerere University, Kampala, Uganda
[2]Department of Agricultural Production, Kyambogo University, Kyambogo, Uganda
[3]Department of Wild Life and Aquatic Resources, School of Veterinary Medicine and Animal Resources, College of Veterinary Medicine, Animal Resources and Biosecurity, Makerere University, Kampala, Uganda
Email: *kabugosteve@gmail.com

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Abstract

A cross-sectional study of 150 purposively selected multiple livestock species farmers was conducted in Central Uganda aimed at distinguishing between mixed and integrated livestock systems. Performance and operational-based challenges misconstrued to cause incorrect comparison between the two systems were considered. Ten multiple-livestock species system with five ruminant species-based and five monogastric species-based combinations were categorised. Poultry, pig, fish, goats and sheep kept in both the 3 and 4-species combinations were considered. Over 80% of the families are male dominated, smallholder and occupying > 1.0 Ha of land. Exotic and crossbred breeds were adopted away from less productive and noncommercial local species. Mixed monogastric-fish systems with monogastric species dominated ($P < 0.05$) the choices in the ten categories. Over five year experience in integrated livestock techniques transformed 30% of the farmers into integrated monogastric-ruminant-fish systems. Over reliance on conventional and expensive feeds was highly associated ($X^2 = 25.93$) with increased production expenses which significantly ($P < 0.001$) reduce production. Cattle and small ruminants are majorly reared on small scale zero-grazing system of less than 5.0 stock per household. Fish gained prominence with 37% of the farmers operating at medium scale of 500 - 1000 stock per farm. Poultry species are mainly kept on deep litter and cage systems which elevated 14.7% of the farmers to large scale with (>1000) stock per farm. Stalls dominate pig management systems with 15% of the farmers upgraded to commercial level with (>50) stock per farm. Ineffective livestock policies contribute to inefficient performance of 55% of livestock farmers. In conclusion, mixed livestock systems should be upgraded to integrated livestock systems with input resource synergy for improved production and sustainability.

Keywords

Integrated Livestock, Multiple Livestock, Mixed Livestock, Management Techniques, Central Uganda

1. Introduction

Over 30 million people live the in-Lake Victoria Crescent (LVC) zone and the majority of these are smallholder farmers engaged in multiple-livestock species production (Nyambo *et al.*, 2019 [1]). Smallholder farmers occupy less than one hectare of land on which they keep livestock and are thus described as "landless" (LVBC, 2007 [2]). Farmers in LVC basically focus more on compatible monogastric production in multiple-livestock species livestock systems for better economic growth (LVFO, 2014 [3]). Over time, increased food insecurity, malnutrition and territorial restrictions of fishing on East African lakes rendered the farmers to incorporate fish in livestock production systems (Steinfeld *et al.*, 2006 [4]). More than 80% of farmers reportedly apply mixed livestock techniques without synergism though diversified at income level, which exposes farmers to financial risks and resource wastage (Khalid *et al.*, 2017 [5]). Mixed livestock systems are identified with low consumer-product confidence, market potential and less cost effective (CARDI, 2010 [6]). Modeling multiple livestock species systems with integrated livestock techniques approach is a remedy to low production and economical inefficiency. Ecological conditions are more sustainable with integrated livestock techniques than either mono or mixed livestock techniques (Sahoo and Singh, 2015 [7]). The use of integrated livestock techniques synergizes resource utilization for increased food production, sustainable income and protection against environmental pollution (Menezes and Hishamunda, 2016 [8]; Dalsgaard *et al.*, 2012 [9]). The characterisation of livestock production is mainly based on diversity, location, land size, breeds, extension services, capital, feed resources, and security (Haobijam and Souvik Ghosh 2018 [10]). An ideal livestock production system design should cater for animal welfare with suitable protocols to boost production (Renggaman *et al.*, 2015 [11]; Temple *et al.*, 2012 [12]). Application of integrated livestock-fish systems is worth in enhancing livelihoods of farmers in LVC (Ogello *et al.*, 2013 [13]). Appropriate policies are necessary to guide science, technology and environmental sustainability of livestock production (Deichmann *et al.*, 2016 [14]; Thornton, 2010 [15]). Livestock policies supportive of livestock production, economic viability and sustainability should be well implemented (Ansari *et al.*, 2014 [16]; NCST, 2014 [17]). However, the farmers should focus on viable and intensified multiple livestock species production (Tatwangire, 2013 [18]). Key areas of consideration in multiple livestock species production are improvement product quality and value addition in marketing (Rockstrom *et al.*, 2017 [19]). The purpose of this study was to identify the categories which differentiate mixed from integrated livestock techniques for improved management, production and livelihoods of farmers.

2. Materials and Methods

2.1. Study Area

The study area was within Lake Victoria Crescent of Central Uganda (UNEP, 2006 [20]). It experiences a bimodal and mean annual rainfall of 1200 mm with temperatures between 16˚C and 28.7˚C (MAAIF, 2011 [21]). LVC has enabling climatic and ecological conditions to sustain over 22 million people thriving on smallholder farming but causing environmental depletion (UBOS, 2015 [22]). Over 50% of fish stocks are depleted due to intensive encroachment on wetlands (LVFO, 2014 [3]).

2.2. Study Design

A cross sectional exploratory study was conducted with smallholder livestock farmers in LVC.

Data was collected from 150 farmers, derived from (Gill *et al.* (2010) [23]) formula:

$$n = p\left(100\ p\right)z^2 / E^2 .$$

where;

n is sample size.

Z is Z value 1.96 at 95% confidence level.

p is the percentage of a sample having a characteristic (50%).

E is the percentage maximum error required.

2.3. Data Collection

A structured questionnaire was used to collected data from 150 respondents. Practicing multiple-species livestock farming of cattle, goats, sheep, pigs, poultry and fish contributions. On farm information about and household characteristics was used and included gender, type of labour and experience, farm size, productivity and income. The respondents were purposely selected from Buikwe (15), Kayunga (28), Mukono (38) and Wakiso (39) district.

2.4. Data Analysis

Quantitative data was analyzed using SPSS software (IBM SPSS statistics 20) to obtain descriptive statistics that were presented in tabular and graphical formats. Chi-square test was used to identify the most significant difference of Categorization of multiple livestock species systems into mixed and integrated techniques in LVC of Central Uganda. For Pearson's chi-square (X^2) was calculated for test statistic:

$$X^2 = \sum (O-E)^2 / E$$

where:

X^2 is the chi-square test statistic

Σ is the summation operator (it means "take the sum of")

O is the observed frequency

E is the expected frequency

3. Results and Discussion

3.1. Characteristics for Categories of Multiple Livestock Species Production

Findings in Table 1 indicate that the males significantly X^2 (df = 1, n = 150) = 19.73, (P < 0.002) dominate and affect the operations of multiple livestock species (MS) production in study area.

Land size of (>1.0 Ha) was significantly X^2 (1, 150) = 15.93, (P < 0.001) key in promoting MS system production as cited by (Nyambo *et al.*, 2019 [1]). Feeds are significant X^2 (1, 150) = 25.93, (P < 0.001) input in MS production and use of

Table 1. Multiple livestock species categories and preferences in LVC of Central Uganda.

Multiple Livestock species categories (n = 150) and preference % (X^2)						
Characteristic variable	**Poultry**	**Pig**	**Ruminants**	**Fish**	**X^2**	**P-value**
Gender of farmers						
Males	42 (3.72)	55 (0.04)	73 (4.82)	56 (0.00)	19.7335	0.000193*
Female	58 (4.83)	45 (0.05)	27 (6.26)	44 (0.01)		
Experience (Years)						
<5.0	38 (0.36)	43 (2.09)	32 (0.18)	25 (2.62)	0.8.0097	0.45811
>5.0	62 (0.19)	57 (1.10)	68 (0.10)	75 (1.39)		
Land size (ha)						
<1.0	56 (2.55)	38 (1.16)	33 (3.32)	54 (1.69)	15.9338	0.00117*
>1.0	54 (2.11)	62 (0.96)	67 (2.75)	46 (1.40)		
Labour provision						
Family	22 (0.05)	25 (0.75)	21 (0.00)	18 (1.06)	4.9799	0.546389
Hired	33 (0.24)	24 (1.32)	34 (0.45)	33 (0.00)		
Family and hired	45 (0.27)	51 (0.11)	45 (0.27)	59 (0.46)		
Feeds						
Conventional	78 (3.44)	64 (0.01)	44 (5.86)	67 (022)	25.931	0.00001*
Non-conventional	22 (5.92)	36 (0.02)	56 (10.08)	33 (0.38)		
Income						
Animal products	64 (0.00)	65 (0.00)	57 (0.87)	72 (0.87)	4.935	0.176616
By-products	36 (0.01)	35 (0.01)	43 (1.58)	28 (1.58)		

*Significant at P < 0.05, X^2 = Chi-square test for characteristics (Individual X^2).

conventional feeds being dominant but increase cost of production which affect over 78% of the poultry farmers (Sahoo and Singh, 2015 [7]). Non-conventional feeds are adopted as either supplementary or substitution of traditional feeds by MS farmers especially with 56% of the ruminant farmers. Farmers concentrate more on livestock products for income generation and less attention on essential by-products (Haobijam and Souvik Ghosh, 2018 [10]).

3.2. Livestock Species Kept by Households in LVC of Central Uganda

The results in Table 2 indicate that a variety of local and crossbred and exotic

Table 2. Livestock types and species kept by households in the study districts.

Multiple livestock species in study district						
Species	**Type**	**Overall n = 150 (%)**	**Buikwe n = 22 (%)**	**Kayunga n = 34 (%)**	**Mukono n = 48 (%)**	**Wakiso n = 46 (%)**
Cattle		123 (82.0)	20 (90.9)	28 (82.4)	42 (87.5)	33 (71.7)
	Local	60 (48.8)	16 (72.2)	17 (50.0)	25 (52.1)	18 (39.1)
	Cross	44 (35.8)	18 (81.8)	19 (55.9)	16 (33.3)	23 (50.0)
	Exotic	28 (22.8)	12 (54.5)	10 (29.4)	15 (31.3)	27 (58.9)
Goat/sheep*		21 (14.0)	4 (18.2)	2 (5.9)	8 (16.7)	7 (15.2)
	Local	14 (9.3)	2 (9.1)	1 (2.9)	6 (12.5)	4 (8.7)
	Cross	10 (6.7)	1 (4.5)	1 (2.9)	4 (8.3)	4 (8.7)
	Exotic	5 (3.3)	1 (4.5)	0 (0.0)	2 (4.2)	1 (2.2)
Fish		65 (43.3)	12 (54.5)	14 (41.2)	22 (45.8)	17 (37.0)
	Tilapia	36 (24.0)	6 (27.3)	8 (23.5)	14 (29.2)	8 (17.4)
	Cat	12 (8.0)	2 (9.1)	2 (5.9)	4 (8.3)	4 (8.7)
	Tilapia +Cat	17 (11.3)	4 (18.2)	4 (11.8)	4 (8.3)	5 (10.9)
Poultry		116 (77.3)	17 (77.3)	28 (82.4)	39 (81.3)	32 (69.6)
Chicken	*Local*	86 (57.3)	15 (68.2)	18 (52.9)	36 (75.0)	28 (60.9)
	Cross	10 (6.7)	10 (45.5)	13 (38.2)	26 (54.2)	21 (45.7)
	Exotic	20 (13.3)	7 (31.8)	12 (35.3)	15 (31.3)	11 (23.9)
Turkey		15 (10.0)	2 (9.1)	1 (2.9)	7 (14.6)	5 (10.9)
	Local	5 (3.3)	2 (9.1)	1 (2.9)	3 (6.3)	2 (4.3)
	Cross	4 (2.7)	0 (0.0)	0 (0.0)	2 (4.2)	1 (2.2)
	Exotic	6 (4.0)	0 (0.0)	0 (0.0)	1 (2.1)	1 (2.2)
Ducks		11 (7.3)	1 (4.5)	2 (5.9)	5 (10.4)	3 (6.5)
	Local	7 (4.7)	1 (4.5)	1 (2.9)	3 (6.3)	2 (4.3)
	Cross	3 (2.0)	0 (0.0)	1 (2.9)	2 (4.2)	2 (4.3)
	Exotic	1 (0.7)	0 (0.0)	0 (0.0)	1 (2.1)	1 (2.2)
Pigs		135 (90.0)	20 (90.9)	31 (91.2)	43 (89.6)	41 (89.1)
	Local	26 (17.3)	3 (13.6)	4 (11.8)	9 (18.8)	10 (21.7)
	Cross	67 (44.7)	10 (45.5)	14 (41.2)	24 (50.0)	19 (41.3)
	Exotic	42 (28.0)	7 (31.8)	15 (44.1)	10 (20.8)	12 (26.1)

*Small ruminant species.

livestock species were kept by farmers in the study area. Most of the households kept a variety of poultry with chicken dominating in Mukono and Wakiso districts. Majority of farmers (57.3%) keep local chicken, exotic and cross bred turkeys and ducks are increasingly reared than local breeds in all districts. Pig farmers (72.7%) are rearing more crossbred and exotic pigs than less commercial local pigs. There 43% of the farmers engaged in fish farming with Nile tilapia dominantly kept than cat fish as commercial species in study districts. Cat fish are kept together with tilapia by (11.3%) in same fish ponds as predatory species to check on excess tilapia fry population bred in ponds (LVBC, 2007 [2]; CARDI, 2010 [6]).

3.3. The Types and Stocking Ranges of Livestock Species

Livestock farmers operate at different stock ranges depending on the resource availability, affordability and accessibility as shown in **Table 3**. Majority of the cattle farmers (47.2%) in the area of study afford to keep 5 - 10 stock more in Buikwe and Kayunga than the rest of districts. Only 10.5% of the farmers can afford commercial cattle keeping of over 15 stock. The goats and sheep are lowly kept in all districts by 21% of the farmers and majority keep less than five head of cattle while at commercial level only afford up to 15 head. Over 42% of the fish farmers in the study area stock 600 - 1000 fish and 27.7% at commercial level with stock range of over 1000 fish. About 38% of the poultry farmers operate at small scale with stock of >250 birds and only 14.7% as large scale commercial farming of >1000 birds. Majority of pig farmers (43%) in all districts at small scale with stock of 10 - 30 pigs and only 5% keep >50 pigs for commercial purpose as agreed by Thonton (2010) [15].

3.4. Multiple Livestock Species Management System

The findings in **Table 4** show that farmers (54%) kept cattle as major livestock species and predominantly raised on zero grazing system than in paddocks and 23.6% of farmers are moving away from the traditional free range system. Goats and sheep as small ruminants arc kept by 14% of the farmers in all districts on zero grazing except in Kayunga where paddocks and free range dominate by 47.6%. Fish are mainly kept in earth ponds by 81.5% of the fish farmers but due to limited farming space, farmers adopted concrete (12.3%) and poly tanks (6.2%). The poultry management system mostly applied by farmers in all the districts is deep litter (73.3%) away from free-range and in cages except for turkeys where more farmers (46.7%) prefer the cages. The pigs were mainly reared in stalls by 82.2% of the farmers and in all districts but 14.7% were using tethering and 3.7% for traditional free range which are getting outdated and phasing out. The inclusion of fish was advantageous as being compatible with ethological habitats and socially acceptable (CARDI, 2010 [6]).

Table 3. Multiple livestock species stock range kept by households in the study districts.

		Percentage of stock range kept by farmers in study districts				
Species	**Stock Range**	**Buikwe n = 22 (%)**	**Kayunga n = 34 (%)**	**Mukono n = 48 (%)**	**Wakiso n = 46 (%)**	**Overall n = 150 (%)**
Cattle		20 (90.9)	28 (82.4)	42 (87.5)	33 (71.7)	123 (82.0)
	1 - 5	50	50.0	47.6	42.4	47.2
	5 - 10	20	28.6	26.2	27.3	26.0
	10 - 15	20	10.7	16.7	18.2	16.3
	>15	10	10.7	9.5	12.1	10.5
Goat/sheep*		4 (18.2)	2 (5.9)	8 (16.7)	7 (15.2)	21 (14.0)
	1 - 5	75.0	100.0	62.5	47.0	66.7
	5 - 10	25.0	0.0	25.0	28.6	23.8
	10 - 15	0.0	0.0	12.5	10.1	4.8
	>15	0.0	0.0	0.0	14.3	4.7
Fish		12 (54.5)	14 (41.2)	22 (45.8)	17 (37.0)	65 (43.3)
	<100	16.7	14.3	13.6	5.9	12.3
	100 - 200	16.6	14.2	22.7	17.6	18.5
	500 - 1000	41.7	42.9	36.4	47.1	41.5
	>1000	25.0	28.6	27.3	29.4	27.7
Poultry		17 (77.3)	28 (82.4)	39 (81.3)	32 (69.6)	116 (77.3)
	1 - 250	41.2	39.3	30.8	34.4	37.9
	250 - 500	35.3	28.6	25.6	21.9	26.7
	500 - 1000	11.8	17.9	25.6	25.0	20.7
	>1000	11.7	14.2	17.9	18.7	14.7
Pigs		20 (90.9)	31 (91.2)	43 (89.6)	41 (89.1)	135 (90.0)
	1 - 10	45.0	45.1	37.2	34.1	39.3
	10 - 20	40.0	48.4	41.9	41.5	43.0
	20 - 40	10.0	6.5	16.2	14.6	12.6
	>50	5.0	0.0	4.7	9.8	5.1

*Small ruminant species.

3.5. Management Techniques Applied in Multiple Livestock Species Production

The results in Table 5 show mixed and integrated techniques that were identified and characterized basing on monogastric, ruminant and fish combinations in multiple livestock species farming (Ogello *et al.*, 2013) [18]. Poultry (Po), pig (Pi), fish (F), goats and sheep (G) were preferred by farmers in the 3 and 4-species combinations. The 3-species Po-Pi-F combination in monogastric mixed techniques were more associated ($X^2 = 0.61$) with 81% of the farmers than in 4-species combinations and species combinations in integrated techniques. The 3-species in ruminant mixed techniques were more associated ($X^2 = 0.28$) with C-Pi-F combination by 68% of farmers than 4-species combinations and

Table 4. Multiple livestock species systems by households in study districts.

Multiple livestock species system by households in study district						
Species	**System**	**Overall n = 150 (%)**	**Buikwe n = 22 (%)**	**Kayunga n = 34 (%)**	**Mukono n = 48 (%)**	**Wakiso n = 46 (%)**
Cattle		123 (82.0)	20 (90.9)	28 (82.4)	42 (87.5)	33 (71.7)
	Paddock	40 (32.5)	6 (30.0))	8 (28.6)	9 (21.4)	6 (18.2)
	Zero grazing	54 (43.9)	12 (60.0)	16 (57.1)	26 (61.9)	21 (63.6)
	Free-range	29 (23.6)	4 (20.0)	3 (10.7)	7 (16.7)	6 (18.2)
Goat/sheep*		21 (14.0)	4 (18.2)	2 (5.9)	8 (16.7)	7 (15.2)
	Paddock	4 (19.1)	1 (25.0)	1 (50.0)	2 (25.0)	1 (14.3)
	Zero grazing	10 (47.6)	3 (75.0)	0 (0.0)	5 (62.5)	6 (85.7)
	Free-range	7 (33.3)	0 (0.0)	1 (50.0)	1 (12.5)	0 (0.0)
Fish		65 (43.3)	12 (54.5)	14 (41.2)	22 (45.8)	17 (37.0)
	Earth ponds	53 (81,5)	8 (66.7)	10 (71.4)	14 (63.4)	10 (58.9)
	Concrete tank	8 (12.3)	3 (25.0)	3 (21.4)	6 (27.3)	4 (23.5)
	Polly tank	4 (6.2)	1 (8.3)	1 (7.2)	2 (9.3)	3 (17.6)
Poultry ***Chicken***		116 (77.3)	17 (77.3)	28 (82.4)	39 (81.3)	32 (69.6)
	Deep litter	85 (73.3)	10 (58.8)	21 (75.0)	30 (76.9)	23 (71.9)
	Cage	11 (9.5)	3 (17.7)	4 (14.3)	6 (15.4)	7 (21.9)
	Free-range	20 (25.0)	4 (23.5)	3 (10.7)	3 (7.7)	2 (6.3)
Turkey		15 (10.0)	2 (9.1)	1 (2.9)	7 (14.6)	5 (10.9)
	Deep litter	5 (33.3)	0 (0.0)	1 (100.0)	4 (57.1)	2 (40.0)
	Cage	7 (46.7)	1 (50.0)	0 (0.0)	2 (28.6)	1 (20.0)
	Free-range	3 (20.0)	1 (50.0)	0 (0.0)	1 (14.3)	2 (40.0)
Ducks		11 (7.3)	1 (4.5)	2 (5.9)	5 (10.4)	3 (6.5)
	Deep litter	7 (63.6)	1 (100.0)	0 (0.0)	2 (40.0)	1 (33.3)
	Cage	3 (27.3)	0 (0.0)	2 (100.0)	2 (40.0)	2 (66.7)
	Free-range	1 (9.1)	0 (0.0)	0 (0.0)	1 (20.0)	0 (0.0)
Pigs		135 (90.0)	20 (90.9)	31 (91.2)	43 (89.6)	41 (89.1)
	Stall	111 (82.2)	16 (80.0)	20 (64.5)	31 (72.1)	32 (78.1)
	Tethering	19 (14.1.7)	3 (15.0)	9 (29.0)	8 (18.6)	6 (14.6)
	Free-range	5 (3.7)	1 (5.0)	2 (6.5)	4 (9.3)	3 (7.3)

*Small ruminant species.

4-species combinations in integrated techniques. As hypothesized Ho > 0.5: Ha ≠ 0.5), monogastric mixed and integrated techniques were significantly (X^2 = 12.161), (P < 0.02) more applicable than ruminant mixed and integrated techniques for both 3 and 4-species combinations in management of multiple livestock species (LVFO, 2014 [3]). Cattle were the core species in ruminant-monogastric-fish combinations and poultry was in monogastric-ruminant-fish combinations. The most applied 3-species combination was cattle-poultry-fish system by 38.7% of fanners followed by poultry-pig-fish (34%). The most applied

Table 5. Mixed and integrated techniques in categorizing multiple species livestock.

Category variable	Multiple-species*					X^2	P-value
Monogastric based systems	Po-Pi-F	Po-Pi-C	Po-F-G	Po-C-Pi-F	Po-Pi-G-F	12.1607	0.016195
Species combination n (%)	51 (34.0)	41 (27.5)	21 (14.0)	26 (17.3)	11 (7.3)		
Mixed technique n (X^2)	81 (0.61)	63 (0.29)	61 (2.74)	69 (0.04)	63 (0.29)		
Integrated technique n (X^2)	39 (1.26)	37 (0.59)	39 (5.67)	31 (0.08)	37 (0.59)		
Ruminant based systems	C-Po-F	C-Pi-F	C-G-F	C-Po-Pi-F	C-Pi-G-F	3.4119	0.491399
Species combination n (%)	58 (38.7)	25 (16.7)	8 (5.3)	46 (30.7)	13 (8.7)		
Mixed technique n (X^2)	51 (0.36)	68 (0.28)	62 (0.05)	61 (0.12)	63 (0.42)		
Integrated technique n (X^2)	49 (0.64)	32 (0.49)	38 (0.09)	39 (0.22)	37 (0.75)		

*Species: C = Cattle, F = Fish, G = Goat/sheep, Pi = Pig, Po = Poultry, X^2 = Chi-square statistic value, P-value is significant $P < 0.05$. Monogastrics include poultry and pigs. Poultry (include: chicken, ducks, turkeys and quails). Sheep and goats are referred to as Small Ruminants.

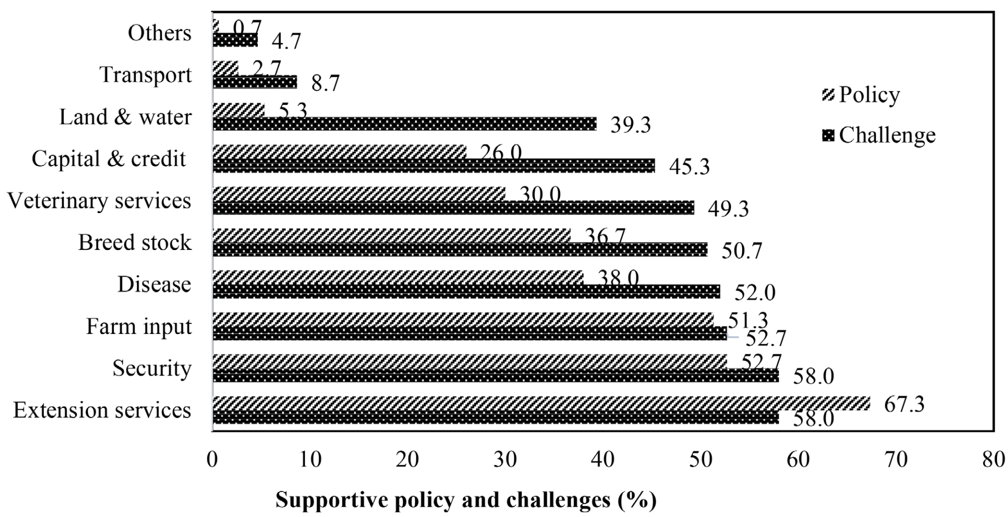

Figure 1. Supportive policies to challenges faced by livestock farmers.

4-species combination was cattle-poultry-pig-fish system (31.7%) followed by poultry-cattle-pig-fish system (17.3%) as indicated by Dalsgaard *et al.*, (2012) [9]).

3.6. The Challenges Faced in the Management of Multiple Livestock Species Systems

The findings in Figure 1 established the challenges that are faced by multiple-livestock species farmers in both mixed and integrated livestock production systems which are in tandem with ineffective and proper implementation of livestock policies. The breed stock demand by farmers stood at 50.7% but the breeding policy target could only meet 36.7%. The policy targets for livestock security and farm inputs could support about 50% of farming challenges. Costly and inaccessibility of extension services affected 58% of the farmers lower than 67.3% of policy plan and mainly affect mixed livestock species farmers (Deichmann *et* *al.* 2016 [14]). Accessibility to credits for capitalization of farms which affect 45.3% of farmers above was 26% of policy target (Khalid *et al.*, 2014) [5] and (Ansari *et al.*, 2017) [16]. Access to land and water availability were big challenges to 39.3% of livestock farmers yet the policy target plan carter for 36% of farmers' needs. Transport means for farm inputs and produce affected 8.7% of farmers yet the policy catered for only 2.7% in agreement with Renggaman *et al.*, (2015) [11]; Temp *et al.*, (2012) [12]. Enhancement of product quality and marketing of livestock products to sustainable livestock-fish farming systems depend on knowledgeable and technically motivated labour force (Tatwangire, 2013 [17]). Basing on socio-economic and ecological synergy of resources in implementation of integrated livestock techniques would be precursors for improving of food security and economic growth (Rockstrom *et al.*, 2017 [18]).

4. Conclusion

There are ten multiple livestock species production systems in Lake Victoria Crescent (LVC) of Central Uganda and these are mainly smallholder, male dominate and rely on family labour which determines livestock categories, techniques and systems of farming. Farmers are adapting to exotic and crossbred livestock away from less productive and noncommercial species. Zero-grazing and stalls are more prevalent in monogastric and ruminant-based in multiple livestock species systems. Cages are increasingly replacing traditional deep litter and free-range systems in monogastric-based systems. Over 80% of multiple livestock species farmers practicing mixed livestock techniques are upgrading to integrated livestock techniques with resource synergism and income diversification. Integrated monogastric and ruminant techniques are more productive and sustainable but require adequate experience to manage. Ineffective livestock policies and implementation affect mixed livestock more than integrated livestock systems. The challenges in mixed livestock techniques could be addressed by adopting more productive and sustainable integrated livestock techniques.

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Ethical Consideration

The study was sanctioned by the Institutional Review Board, School of Veterinary Medicine and Animal Resources, Makerere University for ethical considerations under Ref: SVARREC/05/2018 as mandated and registered as A90ES in accordance with National Council for Science and Technology Act and regulations, 2014 [17].

Conflicts of Interest

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

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