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196- Characterization of smallholder pig production systems in Uganda: constraints and opportunities for engaging with market systems

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Abstract

Pig production has increasingly become an important activity, especially among smallholder farmers in Uganda in the past three decades as evidenced by a dramatic rise in pig population from 0.19 to 3.2 million. This is linked to the rise in demand for pork due to preference changes among other factors. Per capita consumption of pork has been estimated at 3.4 kg/person/year representing a ten-fold increase in the last 30 years. Pigs are important assets for the poor smallholders in Uganda generating income for meeting planned and emergency household financial needs. Despite its importance, the smallholder pig systems are faced with a number of productivity and market related constraints ranging from diseases, poor nutrition and poorly organized markets. Strong growth opportunities to improve smallholder pig systems exist if the constraints are minimized. However the constraints and opportunities vary among smallholder producers as they are not a homogenous group and are affected by various factors. This paper applies a cluster analysis to characterize smallholder pig production systems into typologies in three districts in Uganda by utilizing village level data from 35 villages. The paper further explores the constraints and opportunities for the different typologies to engage with output and input market systems. The paper concludes that different interventions are necessary to improve market linkages with the smallholder pig production systems due to their varying differences in terms of farmers' cooperative involvement, institutional linkages and intensification related indicators.

Keywords: Smallholder pig production systems, Market systems, Typologies, Cluster analysis, Uganda

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1. Introduction

Pig production has increasingly become an important activity in Uganda with pig population rising in the last three decades from 0.19 million to 3.2 million pigs (Uganda Bureau of Statistics, 2009; FAOSTAT, 2011). Uganda has the highest per capita consumption of pork in sub-Saharan Africa with a 2011 estimate of 3.4 kg/person/year representing a ten-fold increase in the last 30 years. More than 1.1 million families, about 18% of total households in Uganda own pigs (Uganda Bureau of Statistic, 2009). The pig enterprise is mostly managed by women and children as a backyard activity in smallholder households in peri-urban and rural areas. The majority of pigs are kept by smallholder households under extensive systems with small numbers of peri-urban small scale, semi-intensive farms and a few large modern intensive farms producing for commercial purposes (Tatwangire, 2012). Households rear pigs because they grow fast, there is a ready market and proven demand and are highly prolific which can result in quick generation of cash (Mutua et al., 2010). In these systems pigs are mainly fed on kitchen food wastes, crop residues, especially sweet potato vines, cassava leaves and peelings, banana peelings and by-products of crops such as maize and cocoyam (Katongole et al, 2012).

Pigs play an important role in risk diversification and livelihood security of smallholder and poor households as they are important assets useful in generating income for school fees payment, purchase of farm inputs and covering emergency cash needs while the manure is used in fertilization of the crop fields. Most of the smallholder pig farmers invest minimal financial capital in the enterprise with the majority in rural settings practicing free range system or tethering with little or no housing (Waiswa, 2005). The sector is largely informal with poorly organized markets, limited access to technology, information and services. Most of the pigs are sold directly to butchers or through middlemen for slaughter in local informal systems. Other constraints associated with the sector include instability of feed supply over the year, lack of feed quality control measures and disease risks such as African swine fever that wipes out pig herds during periods of outbreak or parasites that are endemic and lead to stunted growth which causes reduce market value. Strong growth opportunities to improve smallholder pig systems, adapted to the environment, production objectives and market opportunities exist if the constraints are minimized. However, smallholder pig systems are not uniform group, nor are the constraints associated with those systems; therefore there is not a uniform package of interventions for enhancing productivity and income. The contribution of this paper lies in the identification of different typologies of smallholder pig production systems in three districts in Uganda. By means of a cluster analysis, it combines variables that capture farmers' cooperative involvement through involvement in producer groups, institutional linkages and some intensification related indicators. It further explores the constraints and opportunities for the different typologies to engage with output and input market systems.

2. Methodology

Cluster analysis has been employed in this study to identify different smallholder pig farmer typologies based on village level data. Cluster analysis allows identifying different groups, characterized by maximal within-group homogeneity and between-group heterogeneity. We use the methodology advocated by Punj and Steward (1983) for marketing research, applied by Petrovici and Gorton (2005) and by Jansen (2006a, 2006b) for quantitative livelihood research. In a first step, Ward's (hierarchical) clustering method, based on squared Euclidean distances, is used. This agglomerative method works stepwise to combine pairs of individual observations or clusters while minimizing the within cluster variance (Aldenderfer and Balshfield, 1984). The dendrogram derived from this algorithm allows for visual inspection to determine the optimal number of clusters.

For our analysis, the three cluster solution provides the optimal balance between parsimony and homogeneity. In a second step, the data are clustered through a K-means iterative partitioning analysis. While hierarchical clustering methods have the disadvantage of building upon previous steps without the possibility to revise previous decisions, the K-means algorithm reassigns cases to clusters through an iterative procedure. It allocates data points to the cluster with the nearest centroid, then computes the new cluster centroids, and alternates these steps until no data points change cluster. The statistical criterion it uses is to minimize the sum of the squared Euclidean distances between individuals and their group mean. The number of clusters and the initial cluster centroids are derived from Ward's (hierarchical) algorithm of step 1 (Aldenderfer and Balshfield, 1984; Everitt, 2001). The three-cluster solution using SPSS software is presented in Table 2. The groups of variables used in the cluster analysis were selected apriori not only on the basis of "themes" considered centrally important to the heterogeneity of the smallholder production systems based on previous studies such as Staal et al (2001), but also the planned focus of eventual research and interventions. These themes included farmers' cooperative involvement assessed through membership to producer groups, institutional linkages gauged by the number of institutions involved in livestock value chains within the village and some intensification related indicators comprising breed type, housing, and husbandry practices.

3. The Data

The data used in the analysis is derived from a recent survey of about 1400 pig farmers in 35 villages of Masaka, Mukono and Kamuli districts in Uganda through farmer focus group discussions using participatory rural appraisal (PRA) techniques based on a semi-qualitative checklist. The checklists were developed through working group consultations with scientists from different disciplinary domains from the various CGIAR centres involved in the Livestock and Fish Research Program (CGIAR Research Program 3.7, 2011). The checklist covered various subject domains with the general objective of gaining an understanding on the existing pig system and the associated constraints and opportunities. The three districts were selected by national partners in a participatory manner using geographical targeting through Geographic

Information Systems (GIS) characterization by utilizing existing spatial data in addition to some soft criteria identified by partners. Specifically, data overlays of pig population density, poverty levels and market access were used to depict differences in the districts and variations in the pig value chain types (Van de Steeg, 2013). The pig value chain types have been broadly classified into three based on location and purpose; rural production for rural consumption (rural-rural), rural production targeting urban consumption areas (rural-urban) and urban production for urban consumption (urban-urban). Data on pig population density was derived from the 2008 livestock census report while the poverty levels, based on head count ratios were derived from the human population census data, gridded population maps and the national poverty lines (*ibid.*). Time taken to reach the nearest urban centre was used to proxy market access and served an important role in classifying the districts into different value chain types.

Further location identification within the selected districts was done by using the pig population census data at sub-county level and administration of a minimum checklist to different players for further scrutiny of the existing value chain types. For each district, 2 sub-counties were selected to represent each value chain type. Within each selected sub-county 2-3 villages were randomly selected for the pig value chain activities, yielding a total of 35 villages. Pig farmers lists from each village were then obtained from village administrative authorities, mainly the Local Council 1 (LC1) and local government staff working in the areas. A stratified random sample of 40 pig farmers, based on gender, was then drawn for each village to participate in the farmer focus group discussions. The survey was conducted from November 2012 to February 2013 by local facilitators who were trained on the participatory tools prior to the exercise.

Table 1 contains summary statistics of some of the variables used in the study. On average, 40% of the smallholders participated in cooperative action through membership to farmer groups though a much lower proportion, 7% belonged to pig producer groups, implying that possibly such groups may be non-existent in the study sites. Extensive production systems, especially tethering seemed to be a common practice among the smallholder pig farmers, though a small proportion of farmers, about 30% had pig sties. Common pig husbandry practices by the smallholder pig producers included castration and deworming but few producers gave iron injection. Dummy variables for the value chain types were also included to capture any difference associated with location, though rural-rural type was prevalent. Information was also collected on the different types of pig producers; those who specialize in piglet production and sale (breeders), the ones carrying out fattening and sale of grown pigs (growers) and those doing both. Smallholder pig breeders owned an average of 2 sows including replacement females, while the growers had an average of 2-3 grown pigs. There was a large variation in land size, depending on the location. In the peri-urban areas of Masaka and Mukono districts, land sizes were small with a typical smallholder utilizing an average of 0.11 acres compared to about 4 acres in the rural-rural value chain of Kamuli district.

Table 1: Definition and summary statistics

Variable	Mean	Standard deviation
Cooperative action and institutions		
% male farmers belonging to farmer groups	41.6	35.4
% female farmers belonging to farmer groups	40.2	32.3
% males belonging to pig producer group	7.1	24.7
% females belonging to pig producer group	12.3	28.7
No. of institutions involved in livestock value chains	2.085	1.147
Production system parameters		
% farmers rearing improved pig breeds	59.7	22.0
% farmers rearing local pig breeds	40.3	22.0
% farmers owning pig sties	33.3	30.3
% farmers practicing free range system for pigs	12.9	18.3
% farmers tethering their pigs	43.5	31.4
% farmers producing piglets for sale (breeders)	25.1	21.5
% of farmers specializing in sale of grown pigs (growers)	36.1	29.9
% of farmers doing both (breeders and growers)	42.2	29.1
Average land size (acres)	1.475	1.605
Husbandry practices		
% farmers castrating their male pigs	78.7	23.4
% farmers deworming the pigs	93.5	18.2
% farmers giving iron injection	9.5	21.7
% farmers servicing the sows	54.4	46.2
Value chain type[*]		
% of households in Rural-rural	51.4	50.7
% of households in Rural-urban	20.0	40.6
% of households in Urban-urban	28.6	45.8

[*]There was oversampling of sites under rural-rural domain since they represent the bulk of the poor.

Marketing

In the analysis of the primary market outlets of the grown pigs produced by the households, the results show that most of the households sold to butchers; 60 % to neighborhood butchers and 16% to butchers in other towns. Most of the households indicated that they had no alternative sales outlets apart from the butcheries. Sales to itinerant traders and directly to consumers comprised 20% and 5% by the producers, respectively (Figure 1). The average producer price by the butchers was UGX 5200 per kilo while the traders offered UGX 6000[2].

[2] Exchange rate during the period of the survey: 1US$=UGX2645

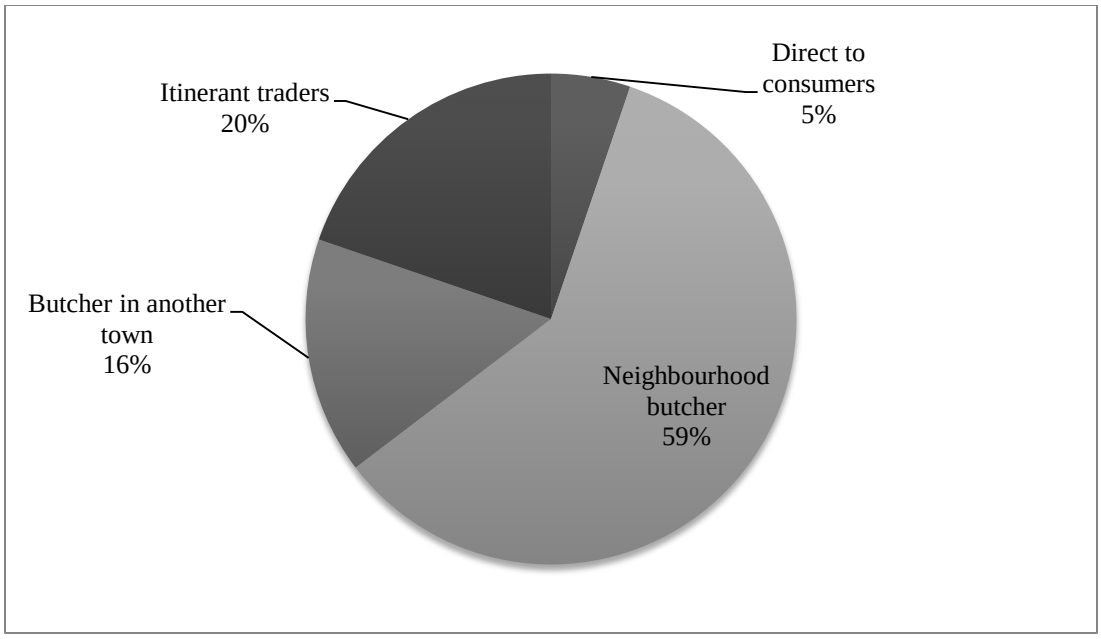

Figure 1: Primary market outlets for grown pigs: % of households

4. Cluster analysis results and discussion

The cluster analysis results show some major differences between the means of various clusters for some variables in the analysis (Table 2). The differences between the clusters are linked to variables associated with farmers' cooperative involvement, institutional linkages and some of the intensification related indicators.

Table 2: Cluster solution

	Cluster 1		**Cluster 2**		**Cluster 3**	
N	*9 (26%)*		*21(60%)*		*5(14%)*	
Variables	Mean	S.D.	Mean	S.D.	Mean	S.D.
% male farmer group membership	29.1	19.8	43.4	39.7	56.7	36.5
% female farmer group membership	**27.1**	33.1	39.6	31.6	**66.7**	20.4
% male pig group membership	**11**	33.3	0	0	**30.0**	44.7
% female pig group membership	**18.5**	37.7	3.8	8.8	**36.7**	50.6
No. of institutions involved in livestock VC	2.3	0.9	1.7	1.1	**3.2**	1.1
% improved breeds	**52.3**	18.0	**57.8**	23.2	**81.2**	8.0
% local breeds	47.7	18.0	42.2	23.2	18.8	8.0
% with pig sties	**12.6**	12.1	**26.9**	14.7	**98.0**	4.5
% free range	15.9	20.8	13.9	18.9	3.4	7.6
% tethered	**68.8**	27.2	**41.0**	27.6	**8.2**	7.9
% castration	87.3	17.8	72.5	25.4	89.2	16.4
% deworming	93.2	8.7	91.9	22.3	100.4	9.2
% iron injection	**2.0**	4.0	**7.1**	17.0	**33.4**	40.5
% servicing the sows	0.0	0.0	**90.7**	13.2	0.0	0.0
Value chain domains (% of villages)						
Rural-rural	66.7		57.1		0	
Rural-urban	33.3		19.0		0	
Urban-urban	0		23.8		100.0	

The cluster solution differences are further explored through analysis of variance (ANOVA) for the different variables to assess the statistical significance of the mean differences (Table 3). For the sake of brevity, only variables that are statistically significant from 10% level are included in the ANOVA table. The between groups means are significant for seven of the variables, indicating that these variables reliably distinguish between the three clusters.

Table 3: Results from the ANOVA

		Sum of Squares	Degrees of freedom	Mean Square	F-value
% female farmer group membership	Between Groups	5060.443	2	2530.222*	2.664
	Within Groups	30388.386	32	949.637	
	Total	35448.829	34		
No. of institutions involved in livestock VC	Between Groups	9.657	2	4.829**	4.404
	Within Groups	35.086	32	1.096	
	Total	44.743	34		
% households with improved breeds	Between Groups	2878.533	2	1439.267**	3.391
	Within Groups	13580.610	32	424.394	
	Total	16459.143	34		
% of households with pig sties	Between Groups	25664.296	2	12832.148***	73.748
	Within Groups	5568.027	32	174.001	
	Total	31232.323	34		
% of households practicing tethering	Between Groups	12109.878	2	6054.939***	9.064
	Within Groups	21375.594	32	667.987	
	Total	33485.471	34		
% of households giving iron injection to pigs	Between Groups	3483.676	2	1741.838**	4.474
	Within Groups	12457.010	32	389.282	
	Total	15940.686	34		
% of households servicing the sows	Between Groups	69051.733	2	34525.867***	318.517
	Within Groups	3468.667	32	108.396	
	Total	72520.400	34		

*, ** and ***, shows statistical significance levels at 10%, 5% and 1%, respectively.

In order to determine where the cluster differences lie, a Tukey *post-hoc* test has been conducted and the results presented in Table 4 (Gore, 2000). The results reveal that the pig confinement status; proportions of households with pig sties, and those practicing tethering reliably differentiate the three clusters through their cluster means. Female farmer group membership only significantly differentiates between clusters 1 and 3, while the number of institutions working on livestock value chains only significantly differentiates between clusters 2 and 3. The proportion of households keeping improved breeds differentiates between clusters 1 and 3 and 2 and 3. Clusters 1 and 2 are not significantly different on this variable. For the husbandry practices, proportion of households administering iron injection to pigs significantly differentiates between clusters 1 and 3, and 2 and 3 while proportion of households servicing the

sows differentiates between clusters 1 and 2, and 2 and 3. Clusters 1 and 3 are not significantly different on this variable.

Table 4: Tukey Post-Hoc Tests Results

Dependent Variable	(I) Ward Method	(J) Ward Method	Mean Difference (I-J)	Standard Error
% female farmer group membership	1	2	-12.545	12.277
		3	-39.594*	17.188
	2	1	12.545	12.277
		3	-27.048	15.334
No. of institutions involved in livestock VC	1	2	.619	.417
		3	-.867	.584
	2	1	-.619	.417
		3	-1.486**	.521
% households with improved breeds	1	2	-5.429	8.208
		3	-28.867**	11.491
	2	1	5.429	8.208
		3	-23.438*	10.251
% of households with pig sties	1	2	-14.341**	5.255
		3	-85.444***	7.357
	2	1	14.341**	5.255
		3	-71.103***	6.563
% of households practicing tethering	1	2	27.754**	10.297
		3	60.577***	14.415
	2	1	-27.754**	10.297
		3	32.823**	12.861
% of households giving iron injection to pigs	1	2	-5.095	7.861
		3	-31.400**	11.005
	2	1	5.095	7.861
		3	-26.305**	9.818
% of households servicing the sows	1	2	-90.667***	4.148
		3	15.851	5.807
	2	1	90.667***	4.148
		3	90.667***	5.181

*, ** and ***, shows statistical significance levels at 10%, 5% and 1%, respectively.

The three clusters can thereby be defined based on their characteristics. Cluster 1 can be classified as “rural extensive and cooperative-poor producers” and largely comprise of villages in the rural-rural value chain types of Kamuli and Masaka district. It accounts for 26% of the surveyed villages. This cluster is characterized by low levels of involvement in cooperative action through farmer group membership (27-29% of households), although a small proportion of farmers, 11-19% belong to pig producer groups. Similar to cluster 2, a few institutions (average of 2) particularly Volunteer Efforts for Development Concerns (VEDCO) and World Vision, both NGOs in Kamuli and Masaka respectively, support livestock value chain activities through advisory services or provision of inputs, including piglets. This may explain the proportion of households belonging to pig producer groups since they may have been created through initiatives of the institutions working on livestock value chains in the areas. In general, there are low investments in the pig enterprise for this cluster in terms of husbandry practices and housing, since most of the pig producers, 69% tether the animals compared to only 12% that have pig sties. The ones with pig sties are largely due to initiatives by the NGOs operating in the areas. There is however, no significant difference in terms of pig breed types with cluster 2. The advantage of this cluster is that land is not a serious constraint, with an average landholding of 2.2 acres per household.

Cluster 2, which is the predominant cluster, with 60% of the villages can be classified as “rural mixed intensive and extensive producers”. It comprises all value chain types, 57% of rural-rural, 19% of rural-urban and 24% of urban-urban domains of the 3 districts. The cluster is characterized by a relatively high involvement of cooperative action through farmer group memberships (40-43% of households), although pig producer groups seem to be non-existent as evidenced by the low proportion of households, 0-4% belonging to such groups. Compared to cluster 1, a relatively high proportion of pig farmers, 27% have pig sties though the majority, 41% still practices tethering. An outstanding characteristic in this cluster in terms of the pig husbandry practices is the high proportion of pig farmers, 90% servicing their sows when on heat. This may indicate ease of access to breeding services through the village boars, the most common practice in the smallholder pig systems where the breeding service payment is paid in the form of 1 piglet or cash equivalent. Average landholding per household in this cluster is 1.4 acres.

Cluster 3 can be classified as “peri-urban intensive associational type producers” and mainly comprise of villages in the urban-urban value chain of Masaka district, largely in the Masaka Municipality. This cluster accounts for 14% of the villages surveyed and are located in less remote areas, largely in the peri-urban settings which may be an advantage for their entrepreneurial undertakings. Members of this cluster have invested in the pig enterprise in terms of pig housing, improved breeds and they undertake most of the pig husbandry practices, apart from servicing the sows. This may imply that most of them do not own sows and may largely be growers/fatteners. For those with sows, they indicate lack of high quality boars within their villages, thereby forcing them to incur high transport cost in sourcing for boars outside their

villages. This cluster has the advantage of availability of a number of livestock value chain supportive institutions (average of 3), particularly the National Agricultural Advisory Services (NAADS) and a number of micro-finance institutions such as BRAC (formerly known as Bangladesh Rural Advancement Committee) and the Foundation for International Community Assistance (FINCA). Some of these institutions play an advisory role to the pig farmers and in some cases provide inputs in the form of piglets or pig housing materials. Most of the pig farmers, especially women in this cluster belong to a farmer and/or pig producers association (67% of women in the farmer associations and 37% in pig producer groups). This cluster has strong growth opportunities for increasing productivity and income, especially for women due to proximity to urban demand centres in addition to the already existing producer groups and other institutions. The landholdings are however relatively small, an average of 0.5 acres per household.

In order to assess income growth potentials through output and input market linkages, constraints and opportunities were assessed for the different clusters (Table 5). The main output market related constraint for producers in clusters 1 and 2 which are largely rural-based, is limited market opportunities. Most of the producers in these clusters sell pigs to neighboring butchers who are also few in some of the locations, thereby resulting in depressed prices especially during beginning of school terms when most producers aim to raise school fees from pig sales. Owing to the strategic location of pig producers in Cluster 3, market opportunities are not indicated as a constraint. Lack of market information, especially on input and output prices for different market outlets and location is however indicated by a relatively high proportion of pig producers, 40% from this cluster. A general problem by producers across the clusters is lack of capacity on pig live-weight estimation. This impact negatively on the producers as the buyers purposely underestimates the weight of the animals in order to maximize on their margins.

Table 5: Constraints associated with input and output markets for different clusters (% of producers)

Constraints	Cluster 1 Rural extensive and cooperative-poor producers	Cluster 2 Rural mixed intensive and extensive producers	Cluster 3 Peri-urban intensive associational type producers
Output markets			
Lack of market information	11.1	28.6	40.0
Limited pig market opportunities	55.6	42.9	0.0
Lack of capacity on pig live-weight estimation	44.4	71.4	80.0
Input markets			
Knowledge on input use	22.2	4.8	20.0
Poor quality inputs	66.7	71.4	80.0
Expensive inputs	90.2	97.1	90.7

Unavailability of outlets supplying inputs	33.3	61.9	20.0

Expensive and poor quality inputs are a constraining factor for producers across all the clusters. The poor quality is largely linked to feeds and veterinary products and is indicated by producers as being sub-standard and less effective due to adulteration or counterfeit products. For clusters 1 and 2, an additional constraint is unavailability of outlets supplying inputs within their localities since most of the input stockists are located in urban centres or large markets. The fact that most of the producers indicate inputs to be expensive may imply that they do not receive good returns on their investments and strategies to improve their returns from the pig enterprise need to be encouraged.

Conclusions and Implications

This article has investigated the different typologies of smallholder pig production systems in Uganda by employing a cluster analysis and utilizing variables that capture farmers' cooperative involvement, institutional linkages and some intensification related indicators. It has also explored the input and output market related constraints and opportunities associated with the different typologies. A hierarchical cluster analysis using Ward's method has produced three clusters, with differences between the clusters being largely attributed to the intensification related indicators. Cluster 1 which has been classified as "rural extensive and cooperative-poor producers" is characterized by low producer involvement in farmer groups and low investments in the pig enterprise. The producers may not invest much in the enterprise due to poor linkages to profitable output markets. It is therefore not surprising that their main constraint is limited output market opportunities. Cluster 2 which is a mixed group comprising both extensive and some intensive producers has similar output market constraints as those in cluster 1 but the difference is the relatively high involvement of producers in farmer groups and higher levels of investments in the pig enterprise compared to cluster 1. Since both clusters are rural based, an associated constraint is access to inputs due to high cost and few outlets supplying the inputs. Both clusters may benefit from improved input and output market integration through collective action and linkages with input providers. Efforts to strengthen collective action through producer groups have been advocated as important avenues for enhancing smallholder producers' bargaining power, minimizing transaction costs associated with marketing and improving access to inputs and technologies (Ouma et al., 2010; Bellemare and Barrett; 2006). Since land is not a constraining resource in these clusters, options for diversification into feed/forage production and marketing for income generation could be explored.

Cluster 3 which is classified as "peri-urban intensive associational type producers" has several advantages including its close proximity to demand areas. There are existing supportive institutions providing inputs, advisory services as well as financial credit to the farmer groups, most of which are women groups. The major lesson drawn from this cluster is the importance of collective action as avenues for accessing extension support, inputs and credit. The main

constraining production factor for this cluster is access to breeding services. Efforts to promote breeding services such as through use of artificial insemination may be beneficial. The main market related constraint for this cluster is lack of market information. Access by producers from this cluster to market information services especially on prices, alternative market outlets and associated transaction costs may enable identification of existing and new market opportunities for pig/pork and related products in order to improve incomes. In all the clusters, capacity needs on different aspects such as pig live weight estimation, input use and husbandry practices is noted. Poor input quality is a common constraint across all clusters. The constraint largely relates to substandard and less effective inputs due to adulteration and counterfeit products. Other studies such as Nkonya and Kato (2001) have also highlighted this as a major constraint in the input marketing sector in Uganda. Input marketing regulations exist but there is laxity in enforcement. However, in order for input use to be effective, there is need for commitment by the public sector or its agencies for quality regulation.

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