Acta fytotechn zootechn, 25, 2022(1): 16–23
http://www.acta.fapz.uniag.sk

Original Paper

Pig breeding practices of smallholder farmers in Uganda

Brian Martin Babigumira[1, 2], Emily Ouma[2], Johann Sölkner[1]*, Karen Marshall[3]
[1]*University of Natural Resources and Life Sciences (BOKU), Division of Livestock Sciences, Department of Sustainable Agricultural Systems, Vienna, Austria*
[2]*International Livestock Research Institute, Kampala, Uganda*
[3]*International Livestock Research Institute, Nairobi, Kenya*

Article Details: Received: 2021-11-05 | Accepted: 2021-12-16 | Available online: 2022-03-31

https://doi.org/10.15414/afz.2022.25.01.16-23

Uganda is among the top five pork producing countries in Africa, with pig production and local pork consumption being on an increase. Smallholder pig farming systems in Uganda are not very well documented. A household level survey of 199 households conducted between July and August 2018 in Kamuli and Hoima districts evaluated the smallholder pig breeding practices. Differences between districts were assessed with a chi-squared test. Farmers mainly relied on animals born on farm, from mating of a sow with an on-farm boar as well as boar service, and animals bought in for use as breeding animals. They were knowledgeable of off-farm sources for fattening and breeding animals. Local and crossbreds of local with 'exotic' types like Large White, Landrace and Camborough pigs were the predominant types of animals accessed by the farmers. The farmers seemed conversant with heat detection methods in the breeding sow. Sow reproductive problems reported by about 40% of the farmers were small litter size and few litters farrowed over the sow's lifetime. While important for farm management and breeding purposes, animal identification and record keeping were generally lacking. Main marketing pathways were sales to other farmers and traders at farm gate. Farmers would benefit from participatory strategies that enhance access to quality genetic material. The local pig is an important resource of the smallholder pig herd and additional studies on important traits (heat tolerance, disease resistance and feed utilization) would add valuable information.

Keywords: Smallholder, pig, breeding practices, Uganda

1 Introduction

The pig sector of Uganda employs 1.1 million smallholder households with a national herd of 4.1 million pigs (UBOS, 2018; UBOS/MAAIF, 2009). Per capita pork consumption in Uganda is 3.4 kg per annum (FAOSTAT, 2018), a comparably high proportion of the annual per capita total meat consumption of 10 kg. Pork production has become a national priority commodity with a forecast production of 139,000 metric tons by 2020 (MAAIF, 2016). To meet such a target and the growing demand for pork, pig farmers must overcome constraints such as poor breeding stock and management (Baker et al., 2015; Muhanguzi et al., 2012). However, there is limited information on breed types and breeding practices in different production systems (Tatwangire, 2014). Additionally, appropriate breeding strategies are absent (Kidoido & Korir, 2013). The main smallholder management systems in Uganda are free range, tether and housing and the main breeds are local, crossbred and exotic (Dione et al., 2014; Ikwap et al., 2014; Muhanguzi et al., 2012). The local pig is small, black and adapted to challenges in the local environment such as disease and poor quality feed stuffs (Mbuza, 1995). Pig breeding in Uganda is unstructured. Sows are bred to communal boars at a fee (cash or piglet) or to boars born on the farm. Further, free ranging sows may access roaming boars particularly in the rural areas. Castration of male animals to control breeding is done under the free-range system (Dione et al., 2014; Ouma et al., 2015). In some cases, sows may fail to access boars from constraints related to lack of knowledge/information (Ouma et al., 2015). The aim of this study was to collect information on pig breeding

***Corresponding Author:** Johann Sölkner, University of Natural Resources and Life Sciences (BOKU), Division of Livestock Sciences, Department of Sustainable Agricultural Systems, Vienna, Gregor-Mendel-Strasse 33, A-1180 Vienna, Austria. e-mail: johann.soelkner@boku.ac.at

practices of smallholder farmers in Kamuli and Hoima districts. The implications for the design of a breeding program are discussed.

2 Material and methods

2.1 Study site and households

The selection of Kamuli and Hoima districts (Figure 1) was based on the importance of pig production to the district implied by the pig population reported in national livestock census (UBOS/MAAIF, 2009) and the high number of pig farmers. Pig production is a priority enterprise in the district plans of Hoima. One hundred ninety-nine households purposively selected based on breed type and management combinations in Kamuli ($n = 100$) and Hoima ($n = 99$) participated in the study.

2.2 Baseline survey

The survey conducted between July and August 2018 targeted the main pig keeper in each household, defined as the main person who fed the pigs. The survey collected information on pig husbandry practices (included pig nutrition, health, housing and breeding), pig marketing, pig farming equipment and phone ownership and usage of phone related services. Only the breeding and marketing sections are relevant to the current study. The 199 respondents that participated in the survey included both women (64.3%) and men (35.7%). Majority of the households (98.9%) kept and managed one pig unit (all animals herded together). The main (96.5%) pig enterprise practiced was a mix of farrow to wean and farrow to finish.

2.3 Data collection, management and analysis

For purposes of this study, the primary data collected through a structured questionnaire during a single visit to each household included breeding information (source of breeding animals, knowledge of sources of different pig types within the village, outside the village and outside the village but within the district, animal recording and identification, sow reproductive problems and heat detection in sows). The marketing information included primary, secondary and tertiary products; breed of product, buyer of the product and method of sale of the product. We considered marketing information relevant to this study as it sheds light on how farmers may define breeding goals and objectives. The survey data was entered into Census and Survey Processing program (U.S. Census Bureau, 2018). Descriptive analysis generated percentages of respondents in R computing program (R Core Team, 2019). A standard Chi square test at a 0.05 level of significance compared the descriptive information between districts. Note that the differences found between districts need to be assessed with care as households were purposively selected based on breed type and management combinations.

3 Results and discussion

The purpose of this study was to evaluate the breeding practices of smallholder pig farmers in Kamuli and Hoima districts of Uganda. District and enumerator could be confounding factors for some of the results.

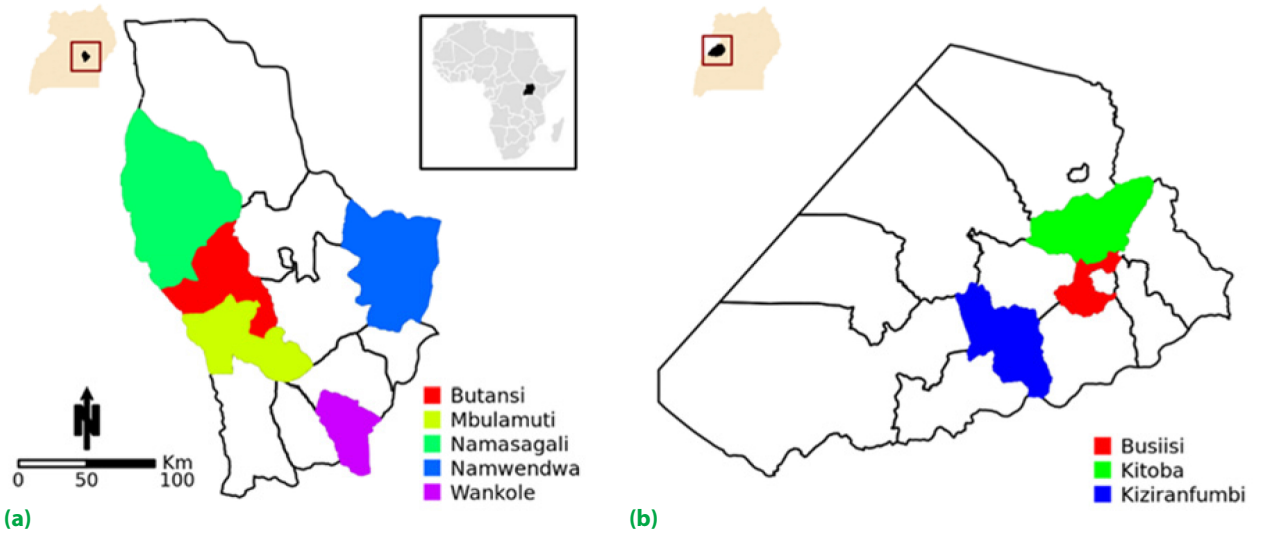

Figure 1 Maps of Kamuli (a) and Hoima (b) districts showing study sites which include five sub-counties in the former and three in the latter. Inset on the left is a map of Uganda showing location of each district. The inset on the right in (a) is the map of Africa showing location of Uganda

3.1 Sources for breeding animals

The main sources used for breeding sows and boars were those born on the farm, from sows serviced by the own boar or a village boar for a fee (see Table 1). Purchases of young pigs from other smallholder farmers were also very frequent. Livestock markets (within or outside the village), large-scale farms, gifts, non-government organizations were the least likely sources for breeding animals. Use of free boars from neighbors or artificial insemination or gifts from friends or family were much less likely sources for breeding sows and boars. There was a significantly (P <0.05) higher percentage of farmers in Hoima than Kamuli that used sows and boars born on the farm. While the difference in purchases of breeding females was not significant between districts, a significantly higher percentage of farmers in Hoima purchased breeding boars from other smallholder farmers. A significantly (P <0.05) higher number of farmers in Kamuli than Hoima used boar service.

Farmers in Uganda have in the past complained about poor performing pig genotypes (Baker et al., 2015; Ouma et al., 2015; Tatwangire, 2014). This study found that majority of farmers in both districts used sows and boars born on the farm as breeding animals. The advantage of using animals born on the farm is the performance information available to guide selection. However, in the absence of a mating system, as is the case in Uganda, the chances of mating close relatives are high and this could lead to inbreeding depression of litter size and growth rate (Tatwangire, 2014; Worsley, 2013). Smallholder pig farmers keep small herds of one to three animals (Ouma et al., 2015) reflecting the limited mating options available to them, often being communal boars for servicing their sow (Dione et al., 2014). It is often assumed that livestock production in low input systems includes mating of close relatives, potentially due to the long use of male breeding animals, also mating their daughters. Mating of close relatives leads to inbreeding which causes a reduction in performance referred to as Inbreeding depression and mostly affects traits related to fitness (Charlesworth & Willis, 2009; DeRose & Roff, 1999). However, a recent study (Babigumira et al., 2021) found low levels of genomic inbreeding (estimated from runs of homozygozity (F_{ROH} = 0.043)) in smallholder pigs in Uganda, being owned by farmers also involved in the current study. The authors claimed that boar keepers usually source boars from outside the local area and the piglets received as payment for boar service are sold. Additionally, farmers with sows may source village boar service from sources outside their village depending on boar availability (Lichoti et al., 2016; Ouma et al., 2014). Another factor that would contribute to low F_{ROH} is that smallholders enter and exit pig keeping all the time (due to their need for money, loss of animals e.g. due to African swine fever (ASF). This means that they are often sourcing new animals from different places (for example, neighbours, markets, or traders) including distant ones (e.g following an ASF outbreak in the community). These scenarios suggest a low likelihood of mating related individuals, thus keeping inbreeding levels low. Low levels of inbreeding based on ROH were found for African goats kept in village conditions, also contrary to popular expectation (Nandolo et al., 2019; Nandolo et al., 2017) The percentage of farmers in Kamuli that had used boars born on their farm was nearly a third of those in Hoima. Dione et al., 2014 found that smallholder farmers in Uganda did not keep boars on their farms

Table 1 Sources of breeding sows and boars used by the household in the last two years. The number of respondents with valid answers was between 95 and 98 depending on the question.

Source of breeding animal	Sow			Boar		
	Kamuli (%)	Hoima (%)	*P*-value	Kamuli (%)	Hoima (%)	*P*-value
Own sow or boar – born on farm	76.8	91.9	0.0034	36.7	91.9	<0.0001
Purchase of breeding female or boar from:						
– large scale/commercial pig farm	8.1	9.1	0.7998	5.1	13.1	0.0505
– livestock market in the village	3.1	1.0	0.3075	1.0	1.0	0.9942
– livestock market outside the village	3.1	1.0	0.3075	3.1	1.0	0.3075
– another smallholder/friend/neighbour	69.7	59.6	0.1371	16.2	49.5	<0.0001
Gifted from friends/family	7.1	0.0	0.0068	5.1	0.0	0.0228
Provided though an NGO or other program	4.1	1.0	0.1705	5.1	1.0	0.0947
Use of a boar sire service (e.g., village boar) for a fee				54.1	36.7	0.0147
Free use of neighbours of friends' boar for free				3.1	3.0	0.9899
Use of artificial insemination				0.0	0.0	

when maintenance costs were limiting. Sows and boars purchased from other smallholder farmers were another source used by farmers in both districts. Similar finding were reported in Teso and Lango regions of Uganda where female breeding pigs may be acquired on credit and payment made when sows farrow (Ssewannyana & Mukasa, 2004). A significantly higher percentage of farmers from Hoima (49.5%) had purchased breeding boars from other smallholder farmers. This study found that a higher percentage of farmers in Kamuli had used boar service for a fee as a source of breeding animals. Ouma et al. (2014) found that when farmers had easy access to a communal boar, over 90% serviced their sows when in heat with payments made in cash or a piglet. In-kind payment was very important means for women to obtain pigs in Kenya and Tanzania (Njuki et al., 2013). Payment in kind allows easy access to the breeding boar since sows may fail to access the boar when farmers are required to pay cash (Mangheni, 2014). Boars determine the productivity of the sow (litter size and weaning rate). Therefore, selection and proper use of the village boar for improved productivity should be included in appropriate genetic strategies (Kidoido & Korir, 2013). Less than 10% of the households from both districts had purchased breeding sows or boars from large commercial farms or livestock markets (within or outside the village). A small but significant percentage (7.1%) of farmers in Kamuli had received breeding pigs as a gift. None of the smallholder farmers had used artificial insemination (AI) as a source of breeding males. Pig breeding by AI is carried out by a few breeding centers in Uganda and is generally unavailable along existing technology uptake pathways (Worsley, 2013).

The respondents had knowledge of sources for local breed, crossbred and exotic piglets for fattening within the village (Table 2). Significantly higher percentages of respondents in Hoima had knowledge of such a source outside the village but within the district. Further, significantly higher percentage of farmers in Hoima had knowledge of a source for local breed young females for breeding both within the village and outside the village but within the district. A significantly higher percentage

Table 2 Respondents who had knowledge of the sources of different pig types within the village, outside the village but within district and outside the district. (Number of respondents with valid answers was 95–100 per site, depending on question)

Pig type	Within district						Outside district		
	Within village			Outside village					
	Kamuli (%)	Hoima (%)	*P*-value	Kamuli (%)	Hoima (%)	*P*-value	Kamuli (%)	Hoima (%)	*P*-value
Piglets for fattening									
Local	97.0	99.0	0.317	79.0	92.9	0.005	3.0	7.1	0.194
Cross-bred (local x exotic)	57.0	59.6	0.710	47.5	68.7	0.002	3.1	7.1	0.200
Exotic	8.0	15.2	0.115	9.1	28.3	0.001	2.0	5.1	0.254
Young females for use as breeders									
Local	66.0	85.9	0.001	52.0	86.9	0.000	3.0	9.1	0.074
Cross-bred (local x exotic)	43.4	43.4	1.000	38.4	49.5	0.115	4.1	8.1	0.241
Exotic	1.0	1.0	1.000	1.0	4.0	0.174	1.0	1.0	0.994
Exotic-Large White	3.0	6.1	0.306	4.0	12.1	0.037	1.0	3.0	0.317
Other exotic	2.0	0.0	0.155	2.0	0.0	0.155	0.0	0.0	NA
Exotic breed type unknown	3.1	8.1	0.125	4.1	14.1	0.014	2.1	2.0	0.984
Boar service									
Local	85.7	93.9	0.056	64.3	93.9	0.000	1.0	8.1	0.018
Crossbred	49.5	59.6	0.155	40.2	66.7	0.000	2.1	6.1	0.162
Exotic-Camborough	2.1	7.1	0.094	2.1	9.1	0.033	1.0	2.0	0.579
Exotic-Large White boar	2.1	2.0	0.984	2.1	6.1	0.157	2.1	2.0	0.975
Other exotic	4.2	1.0	0.167	4.2	1.0	0.163	0.0	0.0	NA
Exotic breed type unknown	5.2	3.0	0.443	4.2	4.0	0.952	2.1	0.0	0.147
Artificial insemination	0.0	0.0	NA	1.1	0.0	0.306	0.0	0.0	NA

of respondents in Hoima had knowledge of a source of local, crossbred and Camborough boar service outside the village but within the district. Less than 10% of the respondents in both districts had knowledge of sources of different pig types outside the district.

The smallholder farmers had knowledge of sources of local or crossbred piglets for fattening, young breeding females and boar services within the village or outside the village. Comparing the percentages of respondents who had knowledge of sources of local or crossbred boar service and those who had used boar service over the past two years, the latter are much lower. This could arise from several factors such as absence of an on-farm sow (no need for a boar) or presence of the boar on the farm. Over 75% of the farmers in the districts had used an on-farm boar. One of the limitations to using boar services are the associated costs (fees and transportation) (Mangheni, 2014). The other is related to biosecurity, African swine fever in particular, as boars are moved between farms in Uganda and Tanzania (Dione et al., 2017; Kimbi et al., 2015).

In a recent study, Babigumira et al. (2021) investigated levels of ancestries of smallholder pigs in Hoima and Kamuli based on high throughput genomic SNP marker data. The results indicate that hardly any of the pigs genotyped had more than 50% exotic (i.e. Modern European) ancestry. This is in accordance with the results of this study, with few farmers knowing about sources of pure exotic germplasm.

3.2 Sow reproductive issues and breeding management

A higher percentage of respondents in Kamuli (73.4%) than Hoima (51.5%) reported no sow reproductive issues in the last five years (Table 3). A significantly higher percentage of respondents in Hoima reported delayed return to heat a few days post-weaning, late age at farrowing, few litters over the sow's life and repeat breeding. Abortions, mummies and stillborn were hardly reported in both districts.

The problems reported by the farmers in Hoima included failure to come back on heat within few days of weaning, late age at first farrowing, repeat breeding and few litters over her productive life. Farmers from both districts complained about very small litter size. Sow productivity may be influenced by sow nutrition and piglet care (Lanada et al., 2005) but also genetics. Sow nutrition is important for conception and maintenance of pregnancy

Table 3 Sow reproductive issues over the last five years

Problem	Respondents who answered the question		
	Kamuli (%; *n* = 94)	Hoima (%; *n* = 99)	*p*-value
No reproductive problem	73.4	51.5	0.002
Delayed return to heat a few days post weaning	13.8	35.4	0.001
Several abortions	1.1	3.0	0.338
Many mummies/stillborn piglets	0.0	3.0	0.089
Very small litter size	13.8	11.1	0.567
Repeat breeding	5.3	16.2	0.016
Late age at first farrowing	0.0	36.4	<0.001
Not have enough litters over her life	0.0	21.2	<0.001

Table 4 Methods of heat detection in the sow used over the last five years

Heat detection method	Kamuli (%; *n* = 94)	Hoima (%; *n* = 99)	*p*-value
Not required, as sow can mate boar anytime	0.0	2.0	0.1660
Look for swollen/red vulva	93.6	98.0	0.1286
Sow makes special sound	21.3	70.7	<0.0001
Sow stands with arched back	0.0	13.1	0.0003
Sow becomes restless	47.9	71.7	0.0007
Standing heat method	2.1	3.0	0.6932
Sow tries to mate other sows	33.0	5.1	<0.0001
Sow shows increased interest in boar	34.0	11.1	0.0001

as well as care of suckling piglets. The effects of poor nutrition could prolong the days open by delaying return to estrus post weaning. The study found that the farmers mainly purchased local and crossbred young breeding females. Local pigs tend to be slow growing and late maturing. This could explain the late age at first farrowing. This study found that local and crossbred boars were the main breeding males used by the farmers. Boar genotype may influence sow reproductive performance (litter size, number born alive and number weaned) as indicated by a study in Zimbabwe (Ncube et al., 2003).

Table 4 provides information about methods of heat detection. Heat detection is an important aspect of sow breeding management. It is important in sows since the estrus period lasts only 2–3 days and the sow must access the boar if she is to conceive (Aiello et al., 2016). The signs used by the majority farmers (over 90%) in both districts to detect heat in sows were swollen/red vulva as reported in the Phillipines (Lanada et al., 2005). In Hoima, additional signs used were restlessness, special sounds and the sow standing with an arched back. In Kamuli, additional signs were increased interest in the boar and mounting other sows. Failure to detect heat could lead to repeat breeding (Dagorn & Aumaitre, 1979). However, this study found that 5% of the farmers in Kamuli and 16.2% in Hoima reported repeat breeding as a sow reproductive problem.

3.3 Record keeping and animal identification

The majority of the respondents in both Kamuli and Hoima kept no records. The most common form of record keeping was mental records, which was more commonly practiced in Kamuli than Hoima (Table 5). The majority of respondents in Kamuli (89.5%) and Hoima (91.9%) did not identify their pigs. A small percentage in Kamuli (10.5%) used coat color and 8.1% in Hoima identified pigs through the dam.

Livestock recording and identification is an important aspect of animal breeding since it makes it possible to track the progress of individual animals. This study found that majority (over 80%) of the farmers did not keep records or use any method to identify their pigs. Record keeping is an important source of pedigree information. This is particularly important in the design and implementation of breeding strategies for the selection and use of village boars to enhance farmer access to quality breeding materials from multiplier units (Kidoido & Korir, 2013).

3.4 Products produced and marketed from the pig enterprise

The primary product produced and marketed from the pig enterprise by majority households in Kamuli was weaners for fattening (82.1%). The weaners for fattening were local (61.5%), crossbred (33.3%) or exotic (5.1%), according to breed types provided by the farmers. The buyers of weaners for fattening pigs were a trader from Kampala (9.2%), a local village trader (18.4%) and smallholder farmers (68.4%). Weaners for fattening were sold at farm gate to individual customers (83.3%) and pig traders (14.1%). The secondary product in Kamuli was finishers for slaughter (72.1%). The finishers for slaughter were local (48.4%), crossbred (46.8%) or exotic (4.8%). The buyers of finishers for slaughter were Kampala trader (44.4%) and local village trader (55.6%). Finishers for slaughter were sold farm gate to individual customers (9.8%; n = 61) and pig traders (85.2%) but directly to the pig slaughterhouse (3.3%). The tertiary product in Kamuli was sows for slaughter (54.8%; n = 31). The sows for slaughter were local (35.3%) and crossbred (64.7%). The buyers of sows for slaughter in Kamuli were Kampala trader (50%) and local village trader (50%).

The primary product in Hoima was young females to use for breeding (65.7%). The young females for breeding were local (58.5%) or crossbred (41.5%). The buyers of young females for use as breeders were smallholder farmers (98.5%). The young females for breeding were sold from farm gate to individual customers (98.5%). The secondary products in Hoima were weaners for fattening (22.2%), young females for use as breeders (23.2%) and young males for use as breeders (39.4%). The weaners for fattening were local (63.6%) or crossbred (36.4%); the young female for use as breeders were local (78.3%) or crossbred (21.7%). The young males for use as breeders were local (53.8%), crossbred (43.6%) or exotic (2.6%). Smallholder farmers in Hoima were the buyers of weaners for fattening (95.5%), young females for use as breeders (95.7%) and young males for use as breeders (100%). The

Table 5 Types of records kept

Record kept	Kamuli (%; n = 96)	Hoima (%; n = 99)	p-value
No records	82.3	93.9	0.0310
Mental records only	10.4	3.0	0.0313
Written as well as mental records	3.1	1.0	0.2802
Written records only	4.2	2.0	0.3488

Table 6 Primary, secondary and tertiary products produced from the household pig enterprises. The number of respondents with valid answers ranged between 31 and 99 depending on the question

Product	Primary			Secondary			Tertiary		
	Kamuli (%)	Hoima (%)	*P*-value	Kamuli (%)	Hoima (%)	*P*-value	Kamuli (%)	Hoima (%)	*P*-value
Weaners for fattening	82.1	14.1	<0.001	4.7	22.2	0.0006	6.5	34.3	0.0025
Weaners for slaughter	3.2	1.0	0.2926	4.7	2.0	0.3137	3.2	0.0	0.0728
Finishers for slaughter	9.5	9.1	0.9268	72.1	7.1	<0.001	19.4	9.1	0.1185
Young females for use as breeders	1.1	65.7	<0.001	3.5	23.2	0.0001	3.2	6.1	0.5417
Young males for use as breeders	0.0	2.0	0.1638	0.0	39.4	<0.001	0.0	19.2	0.0083
Sows for slaughter	3.2	1.0	0.2926	12.8	4.0	0.0297	54.8	25.3	0.0021
Boars for slaughter	0.0	5.1	0.0265	0.0	2.0	0.1851	0.0	5.1	0.2019
Boar sire service	1.1	0.0	0.3061	1.2	0.0	0.2820	12.9	0.0	0.0003
Pig meat	0.0	0.0		0.0	0.0		0.0	1.0	0.5743
Sows for breeding	0.0	2.0	0.1638	1.2	0.0	0.2820	0.0	0.0	

weaners for fattening were sold farm gate to individual customers (95.5) and traders (4.5%); young females for use as breeders farm gate to customers (91.3%) and traders (8.7%) and young males for breeding farm gate to individual customers (100%; $n = 39$). The tertiary product in Hoima was weaners for fattening (34.3%), young males for use as breeders (19.2%) and sows for slaughter (25.3%). The weaners for fattening were local (58.8%), crossbred (38.2%) or exotic (2.9%). Smallholder farmers were the buyers of weaners for fattening (97.1%) and young males for use as breeders (100%). The local village traders were the buyers of sows for slaughter (68.0%).

The goal of any breeding undertaking is an animal that matches the needs of the farmers (customer/end user). Tatwangire, 2014 has previously described three types of pig farmers in Uganda: breeders, growers and a third category of farmers who practice a mix of breeders and growers (keep sows to produce piglets and keep pigs for slaughter). The primary products produced by majority of the smallholder farmers were weaners for fattening in Kamuli and young females for breeding in Hoima. Other secondary or tertiary products produced across the districts were either weaners for fattening, young females and males for breeding and sows for slaughter. Therefore, while this study found that majority of farmers practice a mix of wean to finish and farrow to finish, they may be inclined to one of the two.

4 Conclusions

Smallholder (village) breeding schemes could improve pig productivity by disseminating improved genetics while controlling levels of inbreeding. The study identifies strong and weak points of the current breeding practices. The circumstances under which these smallholder farmers use breeding animals born on farm may predispose the herd to inbreeding. The farmers would benefit from participatory breeding strategies that supply them with quality genetic material from multiplier units. There is a general lack of animal identification and record keeping which is a potential drawback to selective breeding. There is an opportunity to train farmers to record performance data that could feed into a breeding program. This would also support the way farmers select replacement animals from within their herds. The main products are animals for breeding or slaughter and therefore, breeding goals and objectives should account for the heterogeneity in farmer needs.

Acknowledgments

This study was supported by grant funding from the Austrian Development Agency (ADA), and the CGIAR Research Program on Livestock (CRP-Livestock). The authors are grateful to the smallholder women and men pig farmers, Uganda Pig Genetics project staff and officers of the local district administration who participated in the study.

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