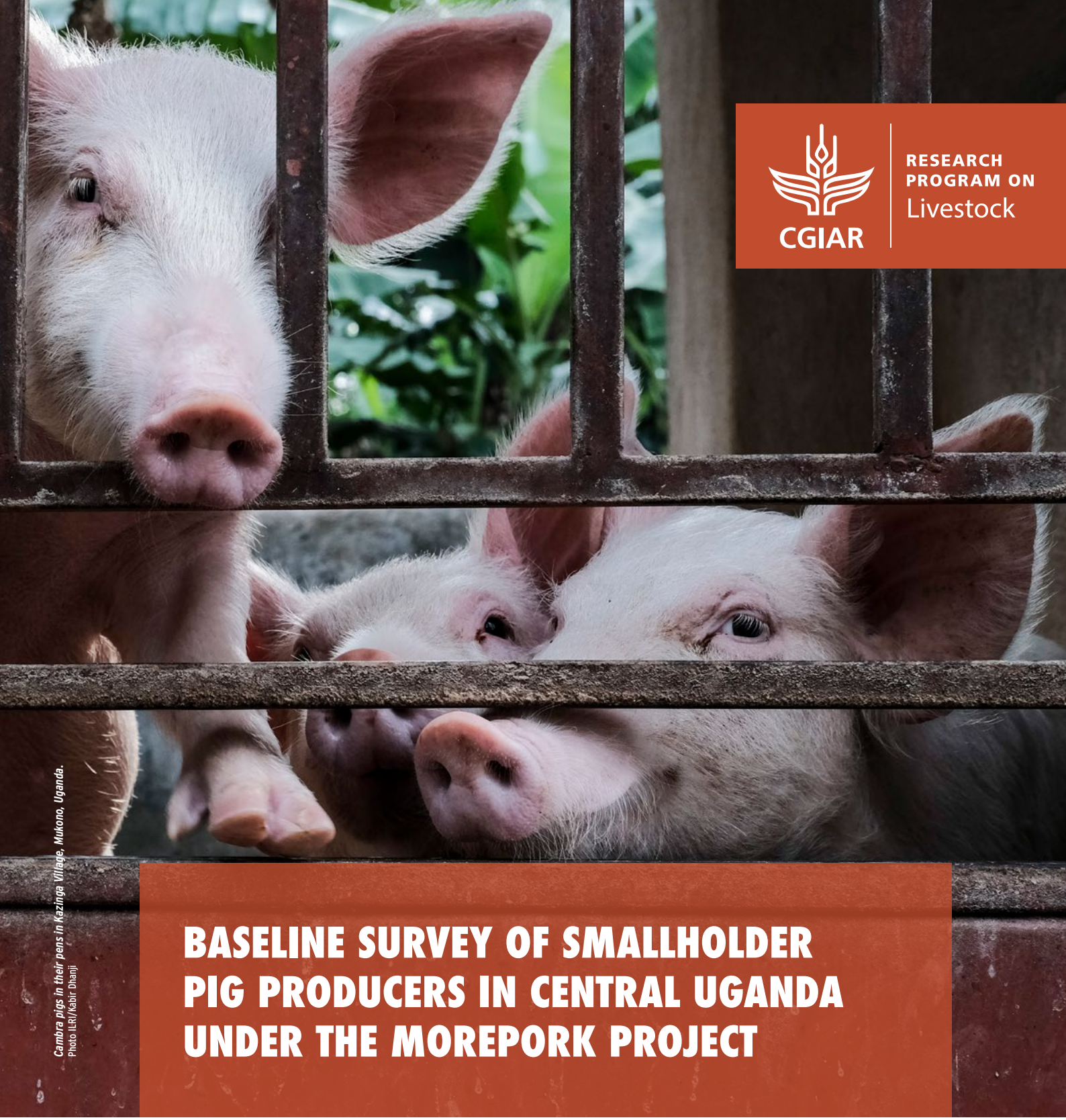

Cambra pigs in their pens in Kazinga Village, Mukono, Uganda.
Photo ILRI/Kabir Dhanji

RESEARCH PROGRAM ON Livestock

CGIAR

BASELINE SURVEY OF SMALLHOLDER PIG PRODUCERS IN CENTRAL UGANDA UNDER THE MOREPORK PROJECT

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International Livestock Research Institute

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Weighing a pig carcass. Photo ILRI/Kabir Dhanji

ACKNOWLEDGEMENTS

We are grateful to all the pig farmers in Mukono, Masaka, Mpigi and Wakiso districts, who dedicated time to participate in the survey and shared their pig farming practices and experiences with us. We appreciate the support rendered to the survey teams by the district local governments particularly the production and marketing departments. We also acknowledge funding support of this work through the CGIAR Research Program on Livestock and all donors and organizations which support the CRPs through their contributions to the CGIAR Trust Fund. https://www.cgiar.org/funders/

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SUMMARY

This report presents a baseline survey for the Livestock CRP Uganda project titled "More Pork". The objectives of the project are to increase pig productivity and production for smallholders, and to link them to pig aggregators and markets, for the purposes of livelihood development. Six-hundred and eighty-eight households were interviewed in four districts of central Uganda. Two are proposed "treatment" areas, where the project activities will be implemented, and two are "control" districts which are included for comparison purposes as the project continues. The districts were called Mukono and Masaka (treatment), and Mpigi and Wakiso (control). The survey focused exclusively on smallholder farmers who raised pigs.

In all the sites, substantial poverty rates were observed, with between one-third ad two-thirds of the households interviewed below the international 1.90 USD purchasing parity power poverty line. Poverty rates were higher in Mukono and Wakiso. The average cash income per person per day was 1.7 USD PPP in Mukono, 2.8 in Waksio, 3.7 in Masaka, and 4.2 in Mpigi. Food insecurity was present, but not extreme. On average households reported that food shortages occurred for one month per year (usually July/August or January), and experience of hunger and food shortages was generally mild (as measured by the Food Insecurity Experience Scale). The diversity of diets (an indication of nutrition) was generally adequate throughout the year, during the leaner months as well as the flush months. Interestingly, Wakiso and Mukono scored slightly better than the other locations on food security, despite reporting lower incomes. It may be related to their proximity to Kampala, and thus better supplied markets.

Sale of livestock (mostly pigs) was the major economic activity amongst interviewees in all four districts, followed by off-farm work. Cash cropping was evident in Mpigi, and small scale cropping for home consumption present in all four locations. The household economies were well diversified, between 60 and 80% of farm produce sold (depending on the district) and between 9 and 12 sources of income reported on average. Land holdings were typically around 1 hectare, and average livestock holdings ranged from 3 TLU (topical livestock units) in Mukono, to 4 or 5 in Mpigi and Masaka, to 7 in Wakiso. This equated to approximately 5 pigs on average kept in Mukono, 6 or 7 in Mpigi and Masaka, and 13 in Wakiso (although many households owned up to 20 pigs). Cattle and goats were also more common in Mpigi and larger scale chicken production in Masaka.

The pig production per household was generally less intensive in Mpigi and Mukono, as judged by the numbers of swine owned, the proportion of improved breeds, the reproduction rates, and the incomes from pig sales. Improved breeds of pig were however widely kept. Around 90% of households in Wakiso and Masaka kept improved breeds, and 50-60% of households kept improved breeds in Mpigi and Mukono. Improved breed sows tended to be younger than local breeds, and generally showed better production. On average, litters (parturitions) were 1 or 2 piglets larger, and the number weaned were higher. However the local breeds showed a slightly smaller gap between parturitions. Artificial insemination was not widely used: around 10% of households had used it in Masaka and Mukono, and 4% in Wakiso and Mpigi. The major route to market was sale of gilts for breeding, and sale of weaners/gilts/growers for slaughter. Purchase of weaners was not uncommon.

Pigs were generally fed residues from grain and legume crops, cultivated forages, gathered forages, grains, and food waste. Concentrates were common in Masaka but not other locations. Grains and concentrates were used more heavily during the dry season to supplement rations. Diseases were fairly common, with about 40% of households reporting pig diseases within the past year (although only 20% in Waksio). Arounds 10% of households reported death of at least one pig during the past year (17% in Wakiso, despite the lower disease rates). The cause of death was predominantly disease, although accidents and starvation accounted for a notable proportion. Gastro-intestinal diseases were the most common (mentioned in 30-50% of disease descriptions); followed by African swine fever and skin infections. Skin infections were very widespread in Mukono and Wakiso (accounting for 70-80% of diseases reported in those locations).

The proposed project interventions included artificial insemination (AI), improved handling of sick animals, heat stress mitigation, improved fencing, record-keeping, and installation of footbaths. As the project was in the initial stage, these had not been widely promoted, and accordingly similar rates of use were observed in the treatment and intervention districts. The specified practices were generally used by 10-30% of respondents, except for AI, which was used by less than 5% of respondents.

The data collected provides a baseline from which to assess changes in pig management, pig productivity and incomes, as well as uptake and impacts of project interventions. These can be linked to any changes observed in household-level livelihoods and food security outcomes.

Photo ILRI/Brian Kawuma

INTRODUCTION

Since 2012, the International Livestock Research Institute (ILRI) has been pilot-testing and validating productivity-enhancing best-bet technological interventions singly to address specific pig value chain constraints, in the framework of the CGIAR Research Program Livestock and Fish, and since 2017 through the Livestock CRP. The best-bet interventions tested previously include improved feeding options using locally available feed resources, capacity building of farmers and other value chain actors such as live pig traders and butchers in pig husbandry and biosecurity practices for control of African swine fever and other pig diseases, and waste management options at the slaughter-node to reduce environmental pollution and improve pork safety through biogas digesters. Results from these interventions showed limited uptake of the best-bets mainly due to financial resource constraints of farmers to invest in them (Dione et al., 2020; Ouma et al., 2018). Such constraints were further exacerbated by market inefficiencies in the value chain that limited farmers access to benefits from technology adoption, thereby disincentivizing uptake. Input and output market inefficiencies such as limited access to input markets that guarantee affordable feeds and veterinary services for pig farmers as well as unreliable access to profitable pork/pig markets, were also documented in Ouma et al (2014). Studies such as Jack (2013) have shown evidence that overcoming such market inefficiencies provides incentives for adoption of profitable technologies by farmers.

While best-bet technological interventions developed under the Livestock & Fish CRP were identified and tested in small scale pilots, the organizational component linking pig farmers to markets which was recognized as key to providing the incentives to uptake of the technologies, is yet to be formulated and tested. Furthermore, there was need to apply a systematic approach to scaling, comprised of structured assessments of scaling suitability of individual technologies and the integrated package through scaling frameworks and implementation arrangements designed to help the CRP systematically navigate the complexities involved.

The CRP Livestock country project in Uganda aims to improve livelihoods of women and men farmers through a sustainable approach that can support stronger and more profitable linkages between pig aggregators and smallholder pig farmers. The project also aims to build capacity of the value chain actors on the best-bet interventions through a digital platform referred to as PigSmart platform. The PigSmart platform is an ecosystem of digital players and contributors working towards efficiency, quality of pigs, profits, and cost reduction among other aspects in the value chain. It links smallholder pig farmers to quality-controlled input and service providers and offers a two-way flow of information that also enhances extension work (Kimani, 2020). Furthermore, the project aims to test candidate climate smart adaptation and mitigation options at the farm level mainly through manure management and heat stress management, in order to minimize the impact of climate change on pig value chains, especially through greenhouse gas emissions, and on the other hand increasing the resilience of pig value chains to changes in climate. To achieve the project objective, a baseline study was conducted to provide evidence-based quantitative and qualitative data to guide implementation of the project interventions. This report presents findings of the pig-farmer level baseline survey conducted in two project pilot districts where the interventions will be implemented and two control districts to facilitate monitoring and evaluation.

Photo ILRI/Kabir Dhanji

Pork joint in Kampala, Uganda.

Photo ILRI/Kabir Dhanji

METHODOLOGY

Pig in a pen.

SURVEY DESIGN

The survey was based on the overall Uganda Pig project study design that includes the inclusion of counterfactual districts to allow for before-after and with or without comparison of the target outcome of the project interventions for farmers, pig aggregators, and input suppliers, and the adoption of productivity-enhancing technologies and practices in the intervention and control districts. The intervention districts (also known as pilot districts) were Mukono and Masaka districts. The selection of pilot districts was based on findings from a scoping study that showed that most of the pig farmers that are linked to the pig and pork aggregators are located in these districts (Ouma et al, 2021 - Pius to add link) The control sites were Mpigi and Wakiso districts. Moreover, the selected pilot and control districts had several similarities such as proximity to Kampala Capital City, and a high pig population density of more than 50 heads/km^2 in Masaka and Mukono. The surveys intentionally targeted households who kept pigs as this was the focus of the project.

SAMPLE SIZE CALCULATION

The sample size calculation focussed on the pig income outcome at the farm level – specifically, variance of pig income, to calculate the sample size for farmers. We used Uganda Pig Genetics project data to calculate the mean pig income and variance in pig income (0.36). The pig farmers targeted for the baseline survey were those linked to the pig aggregators in the project intervention districts and control districts. To detect a 20-percentage point difference in pig income between groups (i.e. change in income for pilot pig keeping households linked to pilot aggregators minus change in income for control households linked to control aggregators) to be realized in 2-3 years, with 80% power and alpha=0.05, and adjusting for unequal sample size, at the ratio of 2 households in pilot for every 1 household in control, yields 195 households in each pilot district (total of 390) and 112 households in each control district (total of 224). Adjusting the n for cluster effects and an intra-cluster correlation (ICC) of 0.2 and a design effect of 2.0, results in an adjusted total sample size of 396 pilot households and 228 control households (see **Table 1**). We added 11% to account for potential drop-outs of aggregators, resulting in a total sample size of 438 farmers in pilot sites and 252 farmers in control sites.

SURVEY IMPLEMENTATION

Data collection was conducted by a team of enumerators that were recruited and trained in the data collection tool, called the Rural Household Multiple Indicator Survey (RHoMIS) tool, integrated into the ODK software application for data collection and cleaning. The RHoMIS tool is a standardized farm household survey tool used to assess the household's farming practices, food

Table 1. Sample size calculation.

	Average cluster size (HH / Aggregator)	Intra-cluster correlation	Design effect	N adjusted	No. clusters (precise)	No. clusters aggregators (rounded)	N Households (rounded)	Add potential drop-out of Aggregators	N Households (including extra Aggregators)
Adjusted for ICC (Inter-vention)	6	0.2	2.0	391	65.2	66	396	73	438
Adjusted for ICC (Control	6	0.2	2.0	224	37.3	38	228	42	252
						Total	**624**	**115**	**690**

consumption, pig productivity, and income indicators, as well as the adoption of best practices and technologies for the pig enterprise. For this study, an additional COVID-19 module was included to assess how the pandemic had affected the households, especially regarding income, food acquisition, and farming activities.

Training of enumerators was conducted for 3 days after which a pre-test of the ODK programmed RHoMIS tool was conducted under the supervision of the ODK specialist, the project field coordinator, and the RHoMIS team. After pre-testing, a feedback session was organized to identify constraints and areas for improvement and updating of the tool. The final tool was pre-tested by the enumerators with pig farmers to ensure comprehension prior to implementation of the survey. Informed written consent was obtained from all the survey participants before the interviews.

DATA ANALYSIS

Descriptive statistics were carried out for the selected socio-economic and pig productivity parameters using the RStudio environment version 1.4.1103 for R (version 4.0.4) using the dplyr package.

Monetary values are reported in USD adjusted for international purchasing parity power (PPP; see https://data.worldbank.org/indicator/PA.NUS.PRVT.PP). The conversion rate used in this study was 1207 Ugandan shillings to 1 USD PPP. This is less than half the market exchange rate at the time, which was 3530 shillings per USD. Monetary values in the report can be converted using these rates.

Various indicators are reported in terms of Male Adult Equivalent (MAE) household members. This is derived on a calorie demand basis – the calorie needs of an average adult male may be 2,500 kCal per day, an average adult female 2,000, a child under one year old 750 calories per day, and so on (see e.g. Coates et al 2017). Food supply and income are thus reported using the household calorie demand as the denominator.

SAMPLE SUMMARY

Household interviews were carried out in the central region of Uganda, between 26th October 2020 and 10th January 2021. Six hundred and eighty-eight interviews were collected across 268 villages in four districts, Masaka, Mpigi, Mukono, and Wakiso (**Figure 1**). Wakiso is close to Kampala; the peri urban location means that farms practice intensive livestock production and depend on food purchases from local markets more so than in other locations.

Figure 1. Location of household surveys.

Sixty per cent of the respondents overall were female, although there were differences among districts with more female respondents in Masaka and Mukono (70% and 64% respectively) compared to Mpigi and Wakiso (around 50% in each district) (**Table 2**). About half of the respondents self-identified as a household head (the remainder were mainly spouse of head; see **Table 1**). According to the enumerator evaluation of responses on survey implementation (reliability and rapport), there was higher reliability in Mukono and Wakiso, than in Masaka or Mpigi, although overall reliability remained high. It was reported that in all sites, it was relatively easy to build rapport with the respondents. The survey duration averaged 75 minutes, which is within the expected duration for the questionnaire, considering the additional detailed questions relating to livestock and the additional questions relating to the impacts of COVID-19.

Table 2. Summary of rural household surveys.

Location	Number of interviews	% Female respondents	% Male respondents	% Household heads	Duration of surveys (avg mins)	Duration of surveys (sd)	% Reliable or very reliable	% Easy or medium rapport
Masaka	225	70	30	50	83	35	61	98
Mpigi	130	50	50	58	74	20	51	98
Mukono	207	64	36	54	75	21	95	99
Wakiso	126	48	52	49	63	17	96	99
Total	**688**	**60**	**40**	**53**	**75**	**27**	**76**	**99**

RESULTS

A rider gets ready to transport pig carcasses to a butcher in Kampala.

Photo ILRI/Kabir Dhanji

HOUSEHOLD CHARACTERISTICS

Household sizes averaged approximately 6 members per household, and the average age of the household head was around 50 years old. Approximately one quarter of households were headed by a single female (**Table 3**). The highest level of education attainment for household heads was primary or secondary school for the majority of households in all districts. In Wakiso, contrary to the other districts, more household heads attained a secondary school certificate (41%) than those who only attended primary school (22%) (**Table 4**).

Table 3. Household characteristics by district.

Variable	District			
	Masaka	Mpigi	Mukono	Wakiso
HH size (members)	5.7	6.3	6.2	6.2
HH size (calorie demand in terms of male adult equivalents)	2.3	3.0	2.7	2.8
HH head age (years)	50	53	54	49
Couple (%)	66	74	73	74
Single male (%)	7	9	2	5
Single female (%)	27	18	24	21

Table 4. Highest level of education achieved by household head.

District	No school (%)	Adult education (%)	Primary (%)	Secondary (%)	Post-secondary (%)
Masaka	1	3	39	28	29
Mpigi	4	4	56	27	9
Mukono	6	2	43	39	10
Wakiso	3	6	22	41	28

LIVELIHOOD ACTIVITIES

Text BoxThe bar charts in **Figure 2** show the total value of households' income and agricultural production. The height of each bar represents the total value in terms of USD adjusted to international purchasing parity power, per male adult equivalent household member, per day. The colours within the bars show where that income or value came from: crops which were consumed, crops which were sold, livestock produce that was consumed, livestock produce that was sold, or paid off-farm activities. Note that due to the differing number of interviews in each farm type, there are differing numbers of vertical bars, as each bar represents one household.

Households in Masaka and Mpigi tended to be the wealthiest in terms of income among the four districts, and Mukono and Wakiso notably poorer. The proportion of households living below the $1.90 USD PPP poverty line was substantial in all four districts: between 36% in Mpigi, 44% in Masaka, 50% in Wakiso, and 61% in Mukono.

Most households produced a basic quantity of crops for consumption (green), and relied heavily on livestock sales (orange) and off-farm employment activities (black) for income. Most households also sold crops in Masaka, Mpigi, and Mukono, although this was not so evident in Wakiso, where crop production appeared to be much less common, which reflects the peri urban character of the location.

ASSETS AND INCOMES PER FARM TYPE

Assets and incomes per farm type are summarised in **Table 5**. Land cultivated varied between 0.9 ha in Masaka and Wakiso, to 1.1.ha in Mukono and 1.6 ha in Mpigi. Livestock ownership was highest in Wakiso with 7 TLU, while livestock holdings were lowest in Mukono (2.9 TLU). The total value of all farm produce, and the actual cash incomes, were lowest in Mukono, but comparatively similar in the other districts. Value of crop production was highest in Mpigi (2266 $/hh/year) and lowest in Wakiso (411 $/hh/year). Value of crop production in Makasa and Mukono was around 1100 $/hh/year. On the other hand, livestock production value was highest for households in Wakiso and lowest in Mukono. Off farm income accounted for a major proportion of total household income. Households in Makasa earned the most from off-farm income, while households from Mukono earned considerably less from off-farm activities compare to the other three locations. In terms of market orientation, households from all districts sold between 63-79% of their farm produce. All farm types had around ten sources of cash income on average.

Figure 2. The total value of activities by district, split by income sources. Income values are in USD adjusted for purchasing parity power using World Bank rates. It is approximately double the market exchange rate of 2021.

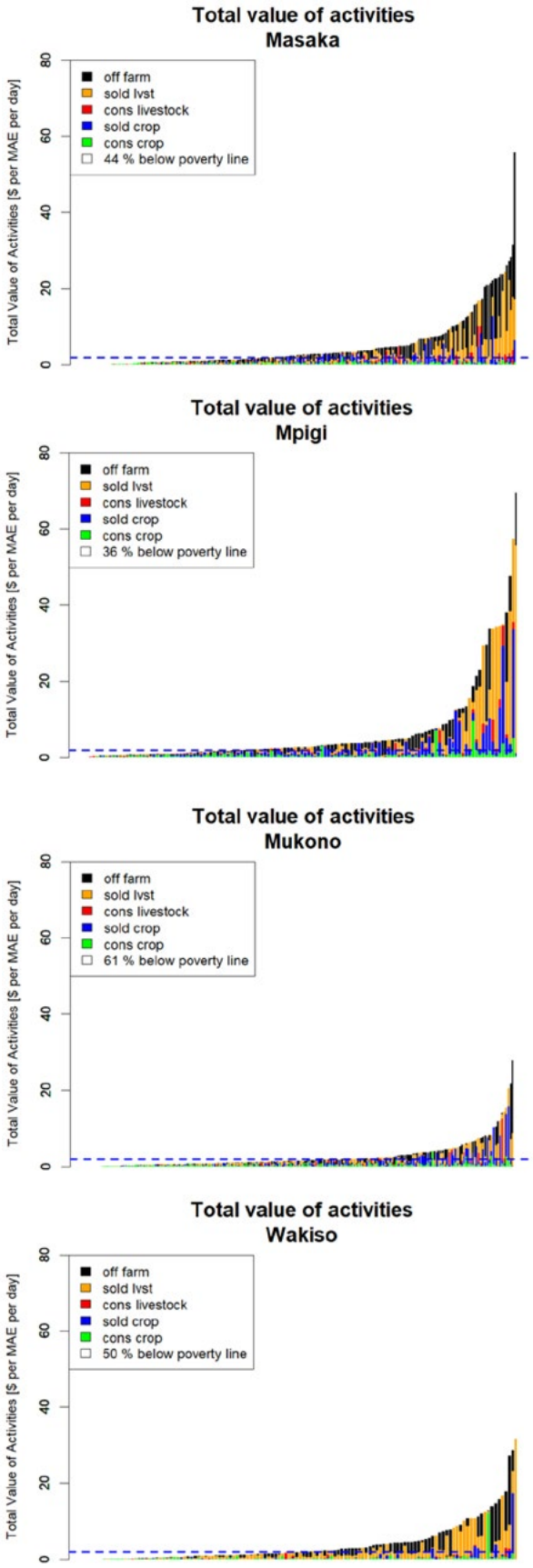


Table 5. Summary of farm assets and income by farm type.

Variable	Masaka		Mpigi		Mukono		Wakiso	
	mean	sd	mean	sd	mean	sd	mean	sd
Land Cultivated (ha)	0.9	2.2	1.6	3.6	1.1	1.1	0.9	1.8
Livestock Holdings (TLU)	4.8	11.6	4.0	6.0	2.9	3.5	7.0	15.0
Total value of production ($/MAE/day)	4.1	7.3	5.1	11.5	2.1	4.6	3.2	5.6
Cash Income ($/MAE/day)	3.7	7.2	4.2	10.8	1.7	3.5	2.8	5.4
Crop Production Value ($/hh/year)	1081	2561	2266	3397	1135	1978	411	1877
Livestock Production Value ($/hh/year)	1567	2928	1296	2819	982	2006	1984	3687
Off Farm Income ($/hh/year)	2232	6878	1493	3165	559	3984	1530	4065
Market Orientation (% produce sold)	73	30	72	26	63	30	79	30
Number of income sources	11	4	12	5	9	4	9	4

FOOD SECURITY

There appeared to be mild food insecurity in the study area. Households from Masaka were slightly more food insecure than households from the other districts, with households from Wakiso being the most food secure among the four districts (**Table 6**). January, July, and August were the leaner months in terms of food availability (**Figure 3**), and are typically the driest months. On the Food Insecurity Experience Scale (FIES), households reported mild food insecurity (scoring 1 or 2 out of a possible 8, where a higher number indicates more experience of hunger). On the household dietary diversity score (HDDS), there was a difference between the flush and lean seasons. Households generally scored about 5 out of a possible 10 during the lean season, and between 6.4 and 7.4 during the flush season (**Table 5** and **Figure 4**). This suggests a nutritionally adequate but not plentiful diet. In terms of the potential calorie availability if all incomes were used to purchase food, and all farm products consumed, households appear to be well able to meet their basic calorie demands.

The food groups consumed were fairly similar between the farm types, with very frequent consumption of grains, legumes, leafy vegetables, and vegetables. Fruits, meat, and eggs were consumed weekly by fewer households (**Figure 4**).

Table 6. Summary of food security indicators by farm type.

Farm Type	Masaka		Mpigi		Mukono		Wakiso	
	mean	sd	mean	sd	mean	sd	mean	sd
Lean months (count)	1.4	1.6	0.9	1.4	0.9	1.4	0.7	1.4
FIES (0-8)	2.0	2.5	1.1	1.8	1.4	2.1	1.1	2.0
HDDS (lean season) (0-10)	5.8	2.6	5.9	2.3	5.6	2.5	6.9	2.4
HDDS (flush season) (0-10)	7.2	1.8	6.8	2.0	6.4	2.2	7.4	2.1
Potential kCal pers day	14,052	26,584	17,180	38,509	8,949	45,637	13,164	23,903

Figure 3. Proportion of households experiences hunger by month and district.

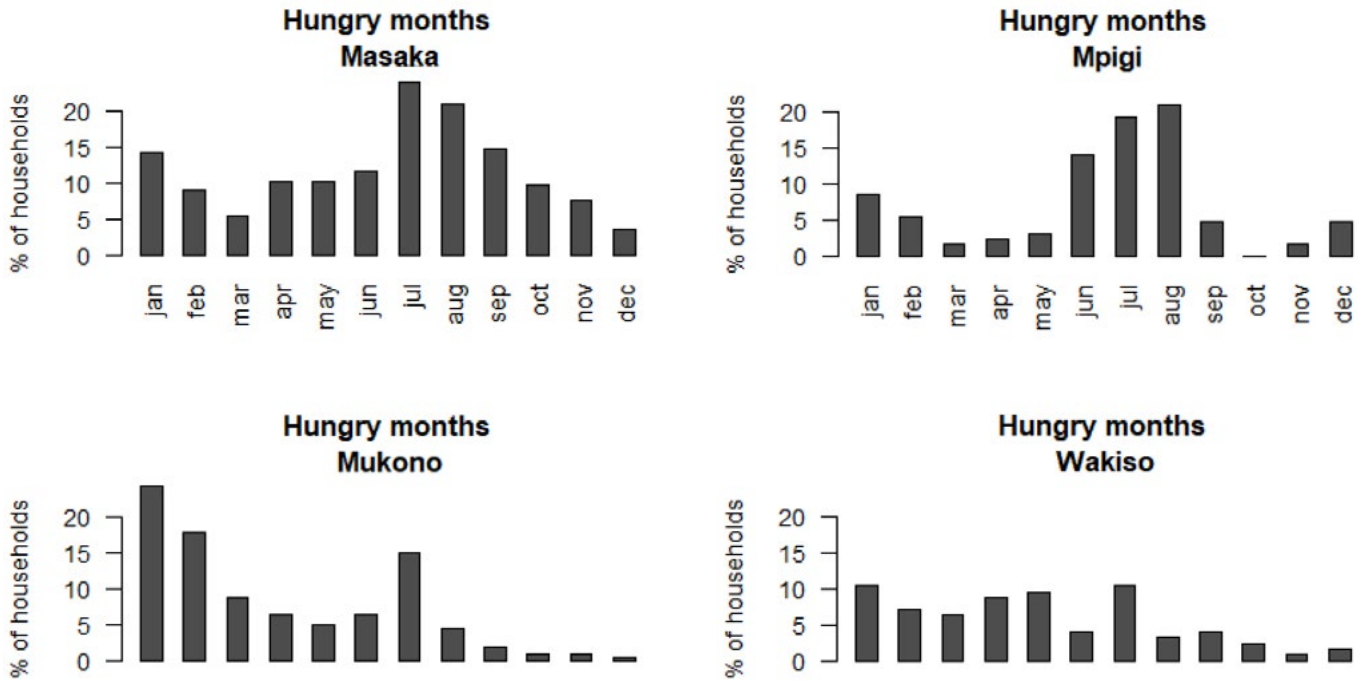
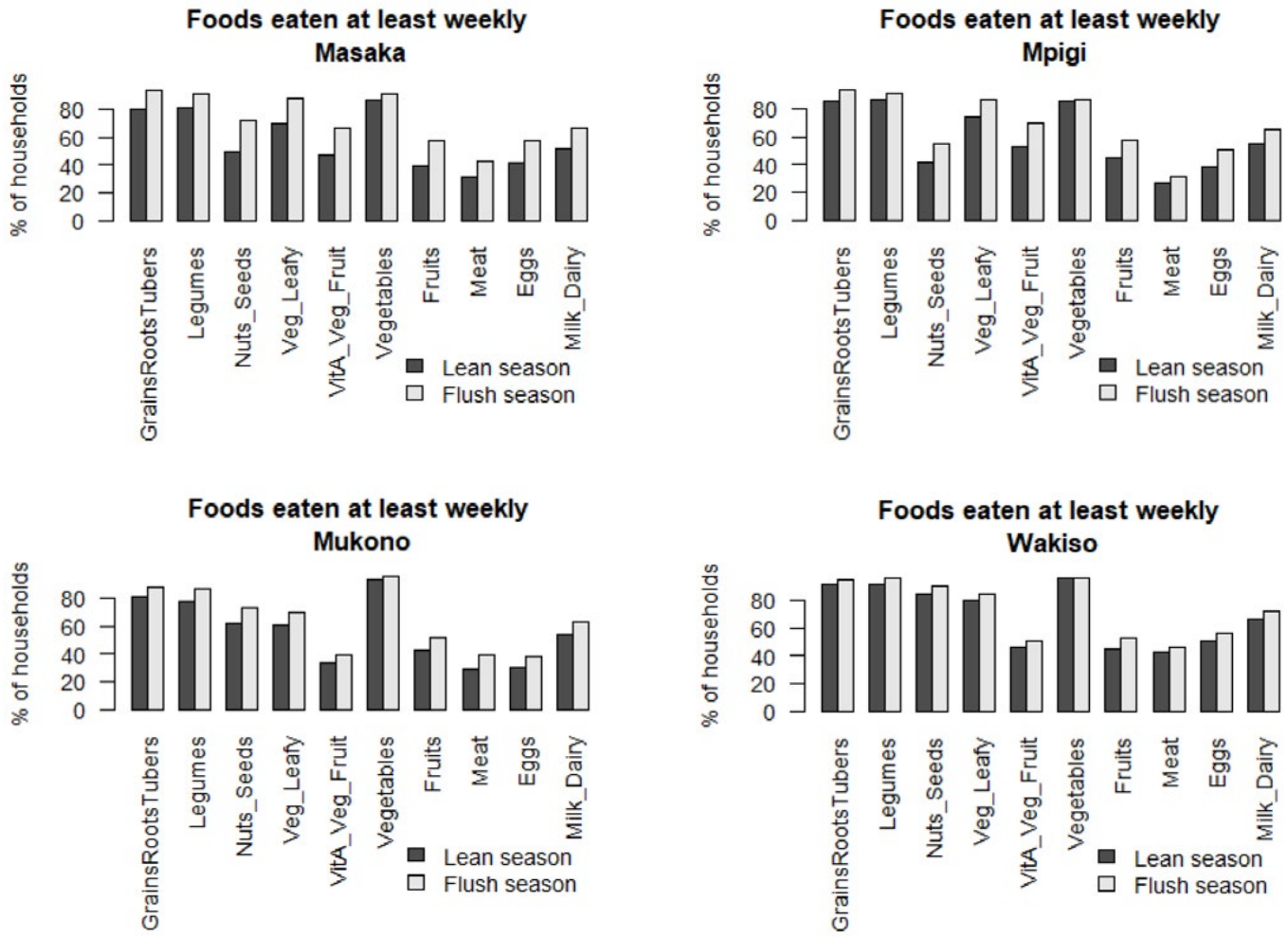


Figure 4. Foods eaten at least weekly by season and district.



GENDER

The bar charts below show female control of production for households in each district. The general pattern was that around 20-30% of households reported fairly equitable levels of control, while there was an important proportion of households in each district (between 15-30%) where control of production was either solely in the hands of the male or in the hands of the female (**Figure 5**).

Figure 5. Female control over farm products and household incomes (both consumption and sales).

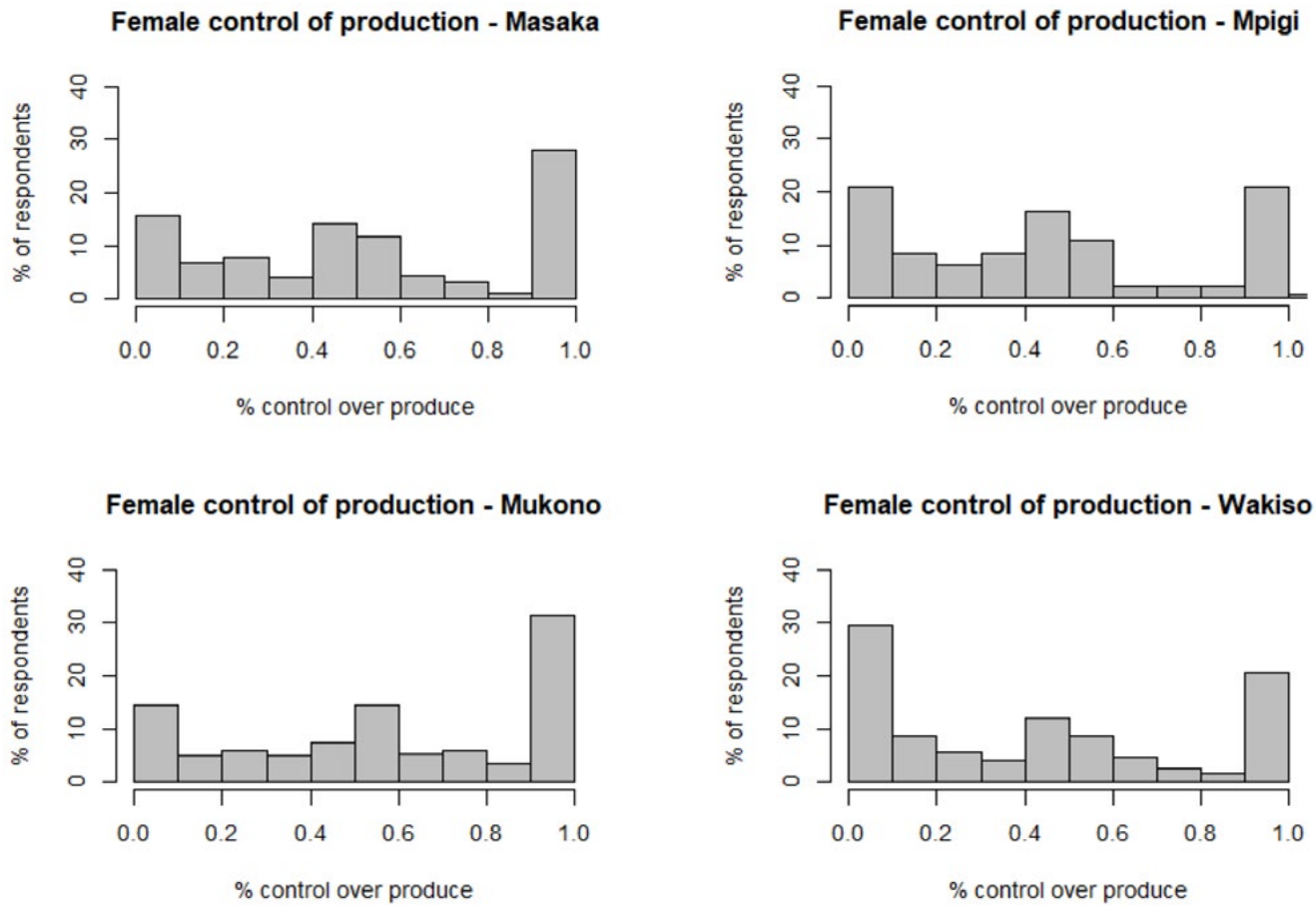


Photo ILRI/Kabir Dhanji

Artificial insemination in pigs, Uganda.

LAND AND LAND MANAGEMENT

Almost all households owned the land they farmed (>90% of housheolds in each district). About 25% of households from Mpigi and Mukono rented extra land for agricutlural use, while around 15% of households from Masaka and Wakiso reported renting in land. Communal land was used by around 4% by households in Masaka, Mukono, and Wakiso, and by around 8% in Mpigi. Farms were generally about one hectare in size, and rarely larger than three hectares. Households from Mpigi commonly had larger farms compared to households from the other districts, reflecting the lower population density (**Table 7**, **Figure 6**).

Photo ILRI/Kabir Dhanji

Kabembe Village, Uganda.

Figure 6. Land area cultivated by district.

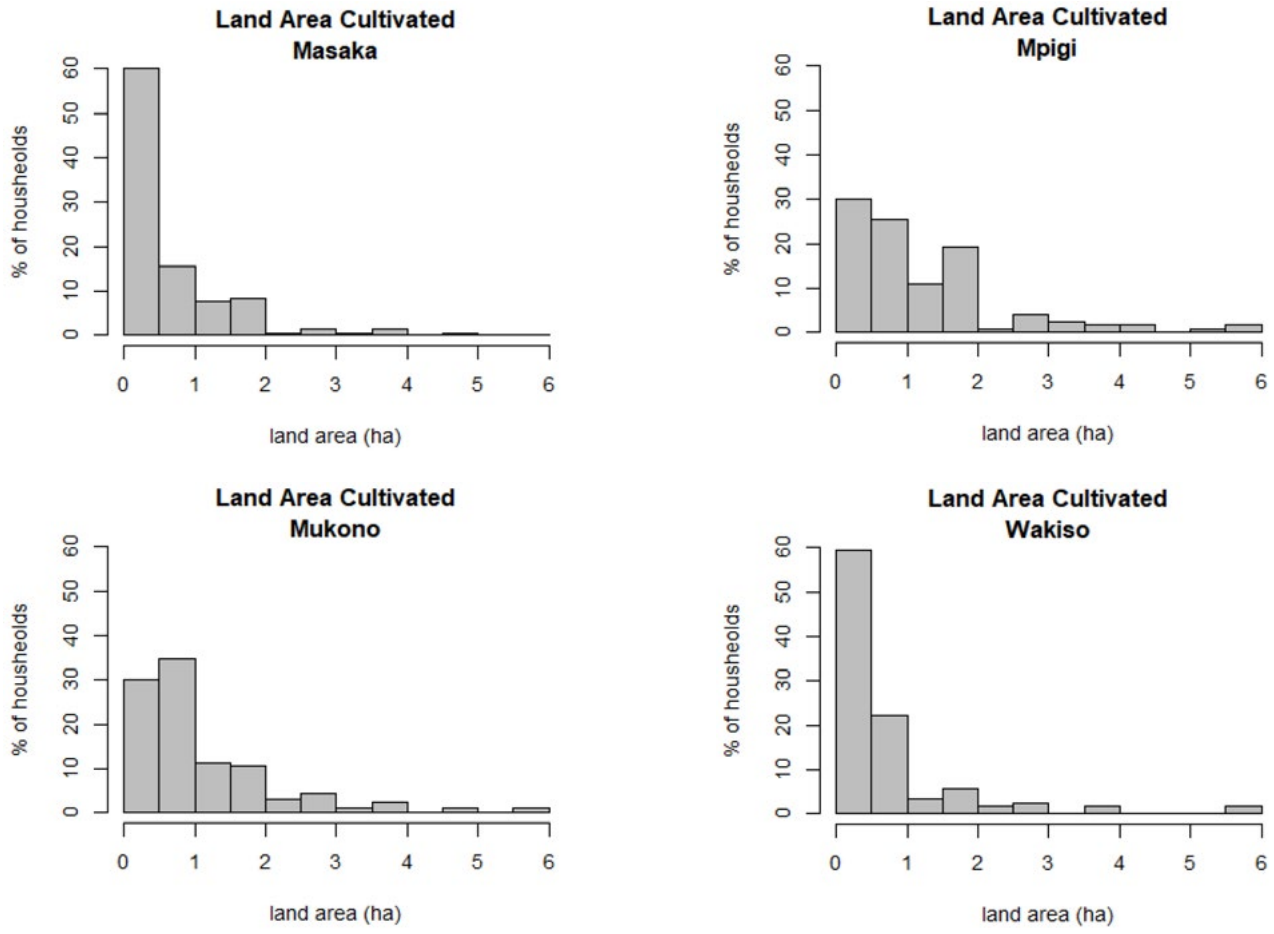


Table 7. Summary of land area owned and cultivated by district.

Typology		Masaka		Mpigi		Mukono		Wakiso	
		mean	sd	mean	sd	mean	sd	mean	sd
Land area (ha)	Cultivated	0.9	2.2	1.6	3.6	1.1	1.1	0.9	1.8
	Owned	2.9	4.6	5.1	9.9	4.1	9.2	2.6	4.7

Soil fertility problems were perceived to be an issue for more households in Mukono (76% of households) than households from the other districts (between 44-62%). Soil erosion and moisture problems were also perceived to be more problematic by more households in Mukono than the other districts. Overall, households from Masaka reported experiencing fewer of these types of problems (**Table 8**).

Irrigation was used by between around 9-15% of households across the four districts. Fertilisers were used by around 30-35% of households in Masaka, Mpigi, and Mukono, but only by 13% in Wakiso. Similarly, fewer Wakiso households used pesticides (25% compared to between 45-67% in the other districts). Manure was used by the majority of households. Hybrid seeds and compost were less common practices in the four districts (**Table 8**).

The most common soil and water conservation measure was contour ploughing in Masaka (28%). In Mpigi, 43% of households practiced strip planting. Ridge furrows were commonly used in Mukono and Wakiso being used by 43% and 36% of the households respectively. Very few households used terraces, percolation pits, check dams, basin planting (**Table 8**).

Table 8. Land and soil management techniques, by district.

Typology		Masaka (% of hh)	Mpigi (% of hh)	Mukono (% of hh)	Wakiso (% of hh)
Farmer perceptions	Soil fertility problems	44	55	76	62
	Soil erosion problems	31	33	56	49
	Soil moisture problems	45	55	73	45
Crop inputs used	Irrigation	15	15	9	13
	Fertilisers	28	38	28	13
	Pesticides	45	67	53	25
	Manure	80	91	85	71
	Hybrid Seeds	23	32	13	10
	Compost	8	9	8	17
	None	4	3	4	0
Soil and Water Conservation Measures	Hill afforestation	10	10	0	0
	Cut off drain	18	15	1	0
	Strip planting	25	43	2	2
	Contour ploughing	28	24	1	0
	Ridge furrow	15	8	43	36
	Water ponds	17	9	0	0
	Soil/stone bunds	13	9	2	0
	Terraces	5	2	<1	0
	Percolation pit	1	0	0	0
	Check dams	<1	1	0	0
	Basin planting	<1	0	0	0

CROPS

Cropping was diverse, with households generally growing six main crops, banana, bean, cassava, coffee, maize, and sweet potato. There was not much difference among districts in this regard, except for Wakiso, where coffee cultivation was less prominent. Around half of the important crops were consumed in the home, except for coffee, which was usually sold in the districts of Mpigi, Mukono, and Wakiso and also tended to generate the greatest amounts of income (Figure 7 and Table 9). Note that although banana was commonly grown, it was not often reported on in detail as households didn't consider it an "important" crop in terms of the total contribution to income of food consumption. Therefore, the summary in Table 8 is based on relatively few observations.

Figure 7. Crops commonly grown in the study districts.

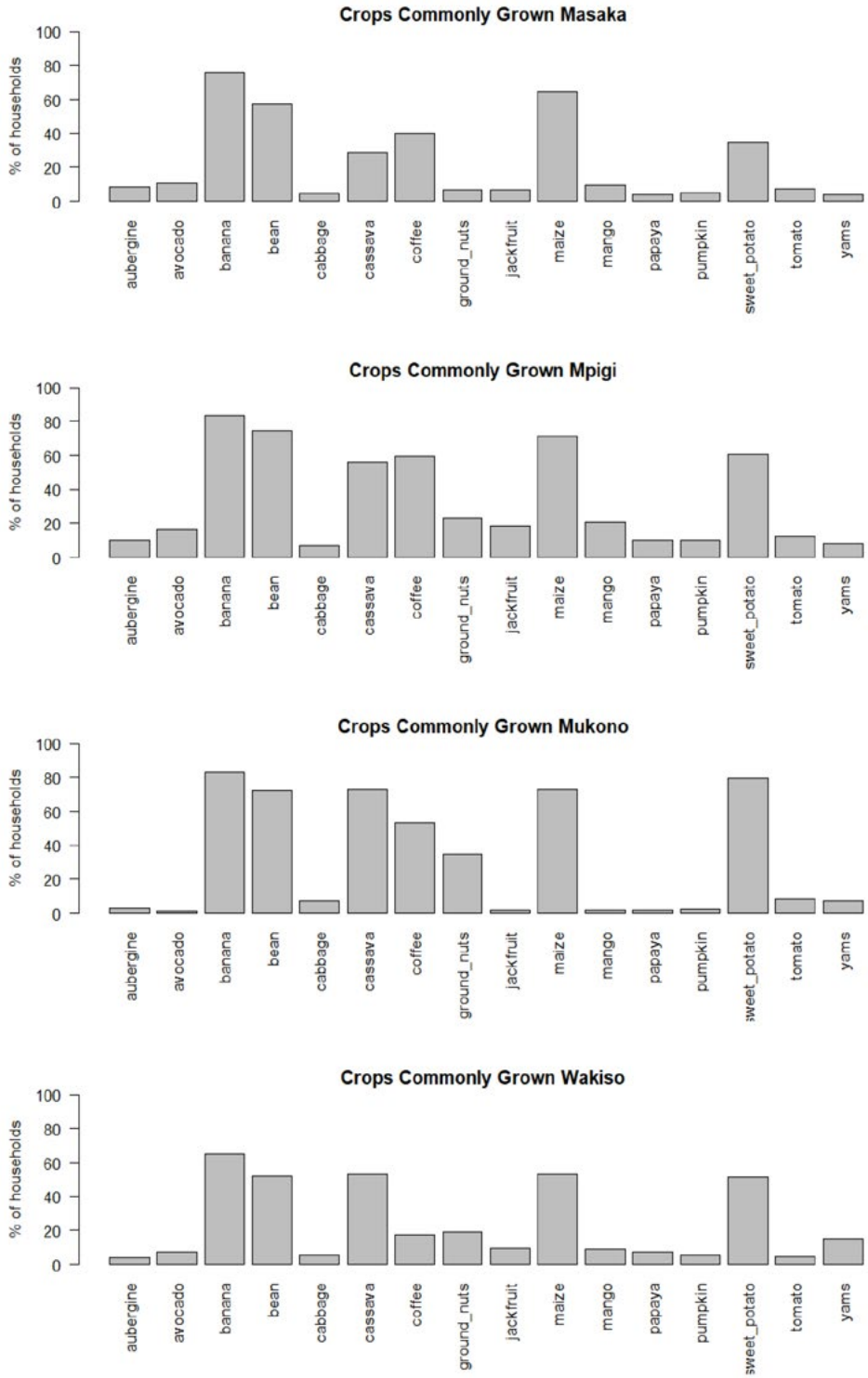


Table 9. Summary of crop production and use for the six most commonly grown crops.

Crop	Indicator	Masaka		Mpigi		Mukono		Wakiso	
		mean	sd	mean	sd	mean	sd	mean	sd
Banana	Harvest (kg)	1166	854	NA	NA	NA	NA	702	840
	Land area (ha)	1.3	2.2	NA	NA	NA	NA	0.2	0.2
	Yield (kg/ha)	5500	6149	NA	NA	NA	NA	8550	7000
	Consumed (%)	40	40	NA	NA	NA	NA	44	51
	Sold (%)	60	38	NA	NA	NA	NA	56	NA
	Sale income ($/yr)	443	431	NA	NA	NA	NA	116	NA
Bean	Harvest (kg)	163	396	324	490	106	354	108	284
	Land area (ha)	0.2	0.4	0.3	0.9	0.2	0.3	0.1	0.9
	Yield (kg/ha)	1429	2923	1399	3770	805	2840	1098	1363
	Consumed (%)	59	29	48	34	62	24	52	17
	Sold (%)	41	21	52	24	38	18	48	6
	Sale income ($/yr)	321	835	545	1352	349	748	1198	1238
Cassava	Harvest (kg)	315	826	496	729	345	651	174	228
	Land area (ha)	0.2	0.3	0.3	1.1	0.2	0.2	0.2	0.4
	Yield (kg/ha)	3325	5760	3329	5983	2715	6326	1920	2794
	Consumed (%)	61	30	55	36	59	27	63	22
	Sold (%)	39	21	45	22	41	22	37	21
	Sale income ($/yr)	684	1355	532	2283	261	441	144	145
Coffee	Harvest (kg)	708	1804	600	4415	377	758	172	176
	Land area (ha)	0.5	1.2	0.4	0.4	0.4	0.6	0.3	0.5
	Yield (kg/ha)	2447	4037	1636	6039	1314	3380	1311	1914
	Consumed (%)	50	NA	0	NA	0	NA	0	NA
	Sold (%)	50	0	100	0	100	0	100	0
	Sale income ($/yr)	1503	3937	859	1556	472	3985	317	248
Maize	Harvest (kg)	560	2105	1070	3082	359	688	342	2174
	Land area (ha)	0.3	0.5	0.4	1.0	0.3	0.3	0.3	1.4
	Yield (kg/ha)	3136	3103	3103	6136	1672	2559	1398	2374
	Consumed (%)	58	39	42	37	52	32	56	32
	Sold (%)	42	27	58	20	48	20	44	24
	Sale income ($/yr)	341	661	761	2072	216	270	234	190
Sweet potato	Harvest (kg)	426	599	963	4200	424	2195	357	4369
	Land area (ha)	0.2	0.5	0.3	0.6	0.2	0.3	0.2	0.4
	Yield (kg/ha)	4115	7289	3642	5814	2457	5230	2703	5134
	Consumed (%)	53	29	51	35	58	27	63	21
	Sold (%)	47	25	49	24	42	24	37	21
	Sale income ($/yr)	369	495	1037	2188	422	3487	325	397

CROP RESIDUES

Table 10 below describes how the different farm types managed their crop residues by the different crops. Beans and maize residues were incorporated back into the soil by around half of the households in the four districts. Coffee residues were also incorporated back into the soil but by fewer households – between 10-41% depending on the district. While also incorporated back into the soils by many households, sweet potatoes and cassava residues were also commonly used as feed. It was fairly common to compost bean, maize, and coffee residues in Masaka and Mpigi (between 8-25% of households), but not in Mukono or Wakiso. Residues were only really used as fuel in a minority of households in Masaka.

Table 10. Summary of crop residue uses by crop and district.

District	Crop	Soil (% HH)	Feed (% HH)	Compost (% HH)	Fuel (% HH)
Masaka	Bean	49	11	12	2
	Maize	53	16	13	3
	Coffee	30	<1	8	5
	Sweet potato	12	29	<1	<1
	Cassava	20	12	1	0
Mpigi	Bean	58	13	24	0
	Maize	52	22	22	1
	Coffee	40	0	8	1
	Sweet potato	17	45	0	0
	Cassava	38	17	0	2
Mukono	Bean	62	2	0	0
	Maize	49	14	1	<1
	Coffee	41	0	0	0
	Sweet potato	31	64	<1	0
	Cassava	41	43	1	0
Wakiso	Bean	48	0	0	0
	Maize	37	9	0	0
	Coffee	10	0	0	0
	Sweet potato	16	45	1	0
	Cassava	21	26	0	2

Nb. The above are the most frequently reported uses. "Burn" refers to burning in situ. "Soil" refers to direct return to soil, whereby residues are left in the field and ploughed back in.

Photo ILRI/Kabir Dhanji

LIVESTOCK OWNERSHIP AND USE

Livestock species ownership was similar in the four districts. All households owned pigs, which reflects the nature of the project (focused on pig production). The second most commonly owned livestock species was chickens, owned by between around 30-60% of households. Cattle and goats were also owned by between 20-40% of households (**Figure 8**).

Figure 8. Livestock species owned by households in the four districts.

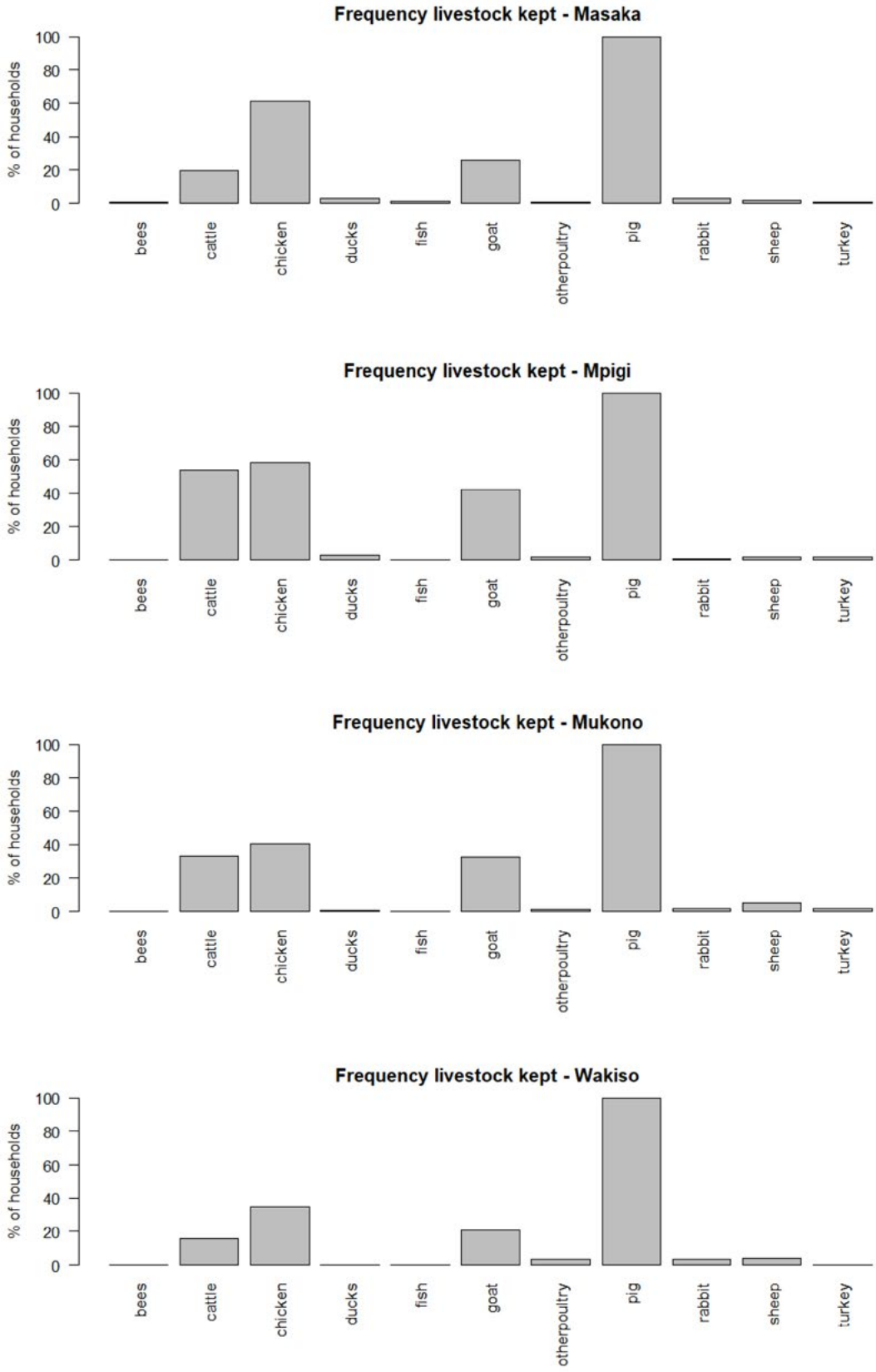


Table 11 provides more detail with regard to livestock ownership and production purpose. Most income generated from livestock was derived through pig production and sales. Income from pig production was highest in Wakiso averaging $1481 year^{-1} and lowest in Mukono averaging $577 year^{-1}. Households from Masaka and Mpigi generated $855 year^{-1} and $673 year^{-1} from pig production respectively. Cattle and chicken production were also important sources of income from livestock production. While whole livestock sales of cattle were low (<1 in every district), average milk yields suggested that cow milk production was an important source of income. Highest income from cattle production was found in Mpigi ($214 year^{-1}) and lowest in Masaka ($35 year^{-1}). Income from chicken production was much higher in Masaka and Mpigi ($380 year^{-1} and $111 year^{-1} respectively) compared to Mukono and Wakiso ($7 year^{-1} and $21 year^{-1} respectively).

Table 11. Summary of livestock production variables by livestock species and farm type.

Livestock species	Indicator	Masaka		Mpigi		Mukono		Wakiso	
		mean	sd	mean	sd	mean	sd	mean	sd
Pigs	kept (count)	7.0	11.2	5.7	8.9	5.3	7.5	12.5	17.7
	sold (count/yr)	6.7	26.7	5.0	16	4.4	8.0	8.9	16.3
	slaughter (count/yr)	0.1	0.6	0.2	4.3	<0.1	0.9	0.1	1.6
	cash income ($/yr)	855	5795	673	4738	577	1145	1481	3011
Cattle	kept (count)	0.3	5.6	1.3	2.2	0.7	2.2	0.3	4.1
	sold (count/yr)	0.1	3.8	0.3	1.0	0.3	0.9	0.6	0.8
	slaughter (count/yr)	0	0	0	0.1	0	0	0	0.2
	milk yield (litres/cow/day)	3.1	2.5	1.1	1.6	2.0	2.2	2.6	1.5
	cash income ($/yr)	35	2399	214	4030	106	3287	119	3120
Goats	kept (count)	0.6	2.3	1.4	5.5	0.9	2.5	0.7	5.1
	sold (count/yr)	0.6	1.5	0.4	1.4	0.4	1.5	2.0	6.1
	slaughter (count/yr)	0.1	0.4	0.1	0.6	<0.1	0.5	0.3	1.2
	milk yield (litres/cow/day)	0.4	0.3	0.4	0.4	NA	NA	NA	NA
	cash income ($/yr)	3	103	12	246	2	97	22	320
Chicken	kept (count)	37.8	686.5	11.7	333.4	3.8	33.9	8.8	181.0
	sold (count/yr)	18.4	225.2	11.5	69.2	1.9	21.7	32.7	543.2
	slaughter (count/yr)	7.2	12.0	7.9	9.3	3.1	6.4	4.4	210.9
	eggs /chicken /day	0.5	1.4	0.5	1.4	1.1	1.7	0.1	1.2
	cash income ($/yr)	380	6167	111	4982	7	1464	21	4129

Photo ILRI/Kabir Dhanji

LIVESTOCK FEEDING

Crop residues and grains were the most popular types of animal feeds in the four districts with between around 70-95% of households using both types of feed. While concentrates were used by over half of households in Masaka, they were only used by around 20% of households in the other three districts. Food waste and gathered forage were also important constituents of the livestock feed basket with between 40-70% of households across the four districts using these feeds. There was greater variability in the use of legume crop residues with more households from Mpigi (nearly half) using these types of feed than the households in the other districts. Cultivated forage, by-products, grazing, and insects were rarely used by households in the four study sites (**Figure 9**).

Figure 9. Proportion of households using feed types by district.

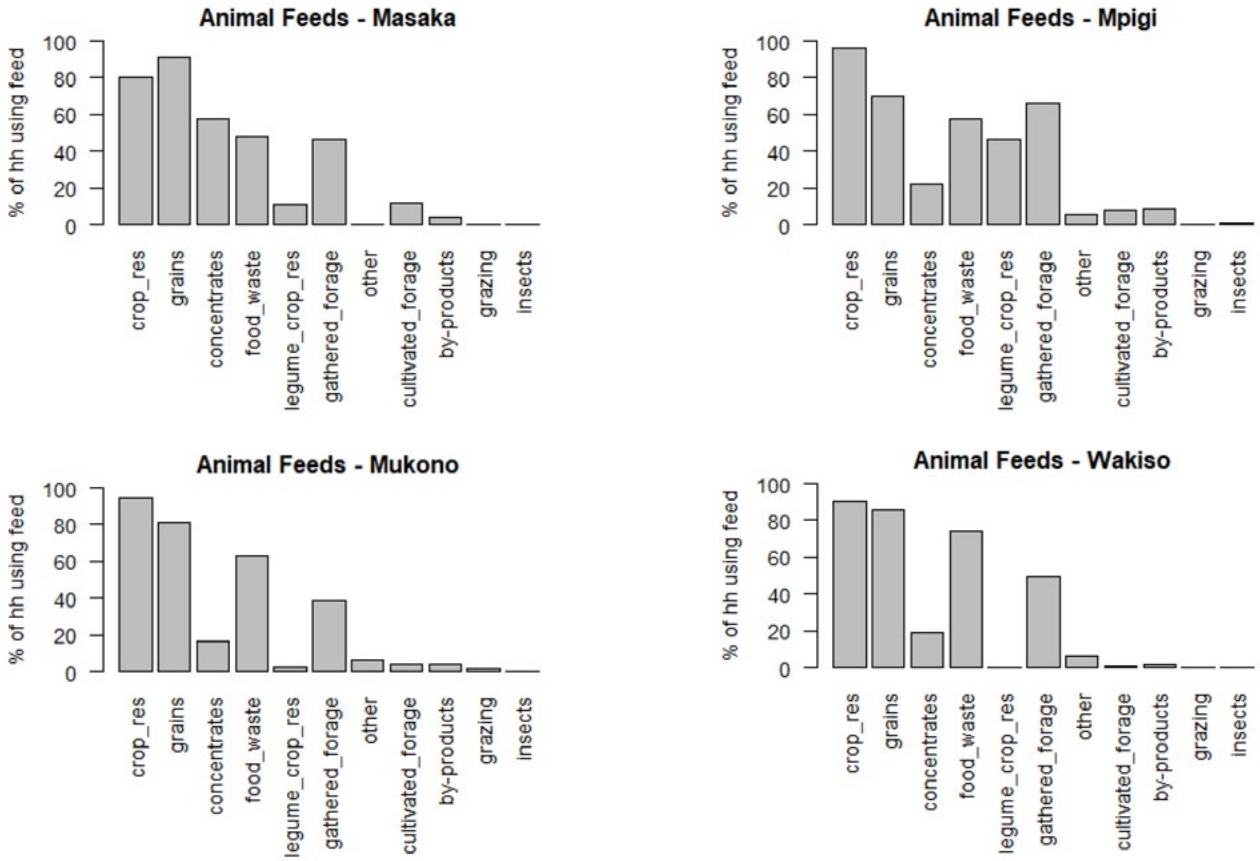
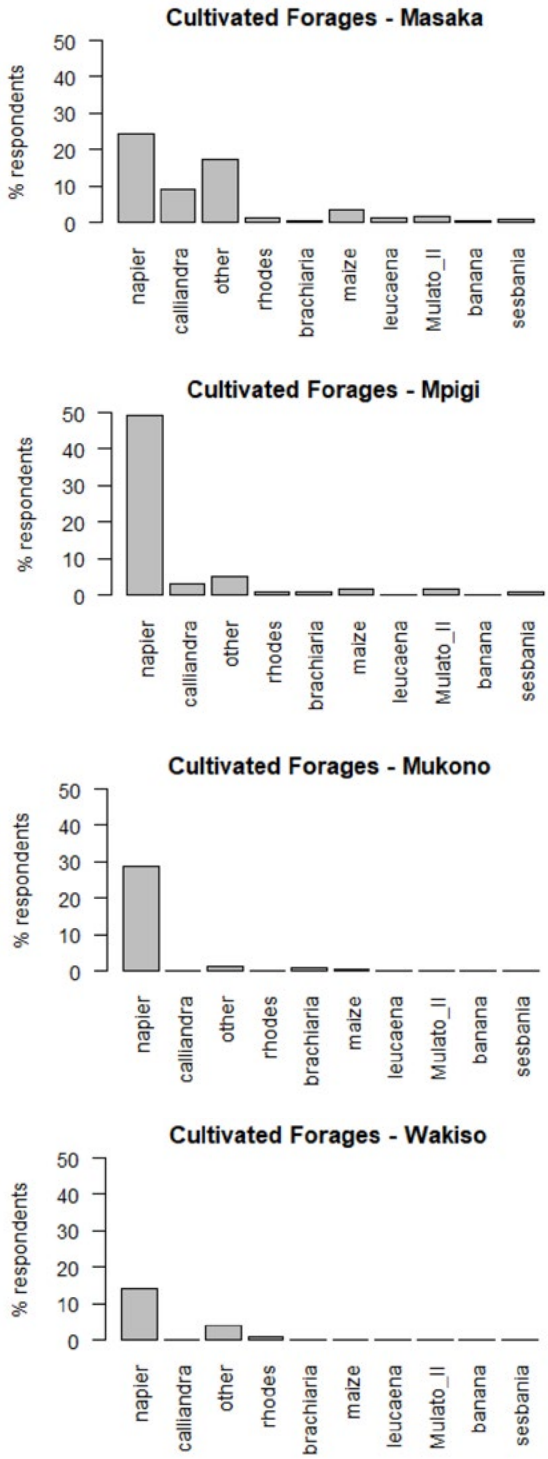


Photo ILRI/Kabir Dhanji

Processing feed for pigs.

Napier grass was the most common forage grown by households in the four districts, being cultivated by nearly half of households that cultivated forage crops in Mpigi and between 10-30% of households that cultivated forage crops from the other three districts. Calliandra was cultivated by just under 10% of households that cultivated forage crops in Masaka. "Other" cultivated forages comprised mostly of sweet potato and yams plants and residues (**Figure 10**).

Figure 10. Proportion of households cultivating different types of forage by district.



The feed basket for pigs varied throughout the year with residues and forages being used in the wet season, and more concentrates and grains being used in the dry season (**Figure 11**).

Figure 11. Composition of pig feed baskets, showing feeds during the wet and dry seasons.

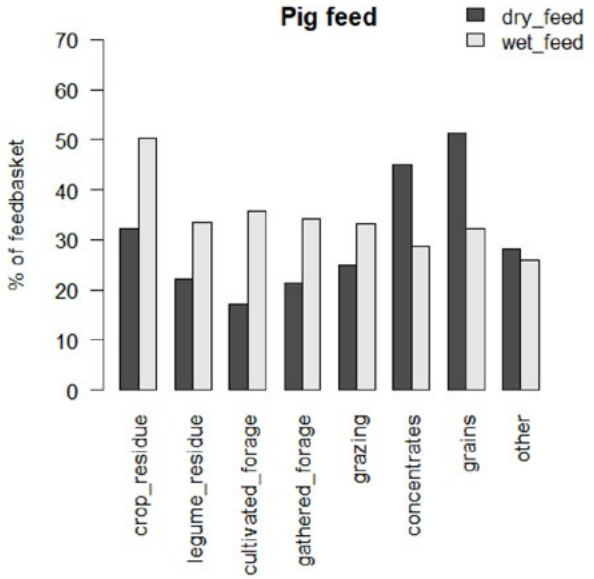


Photo ILRI/Kabir Dhanji

Feeding time for pigs.

PIG-FOCUSED FINDINGS

HERD COMPOSITION AND DYNAMICS

Herd sizes varied between districts from just over 5 heads in Mukono to over 12 in Wakiso. Variability among households was also high, with the standard deviation in Wakiso reaching 17.7. The majority of the pigs were improved breeds in Makasa (91%), Mukono (66%), and Wakiso (87%). In Mpigi, about half of the pigs were from an improved breed. There were more improved breed sows than improved-breed boars in all districts. The age of the oldest improved breed sow was much lower than the oldest local breed sow in all of the districts. The age of the oldest local breed pigs varied between 15-22 years depending on location. The number of female pigs with more than one parturition during the last year was greater for improved breeds than the local breeds. Birth rates were around 1.5 across districts (**Table 12**).

Table 12. Summary of pig breeding variables by farm type.

	Masaka		Mpigi		Mukono		Wakiso	
	mean	sd	mean	sd	mean	sd	mean	sd
Pig herd (size)	7.0	11.2	5.7	8.9	5.3	7.5	12.5	17.7
Proportion with improved breed (%)	91	–	50	–	66	–	87	–
Total piglets (live births/year)	14.6	33.2	9.7	20.9	8.4	11.2	22.5	49.3
Birth rate (livebirths/head of livestock/ year)	1.6	3.0	1.4	1.8	1.8	5.5	1.4	1.7
Improved breeds: Number of sows	1.3	2.7	0.7	2.0	0.6	1.5	1.6	2.8
Improved breeds: Number of boars	0.4	0.9	0.2	0.6	0.2	0.4	0.5	0.9
Improved breeds: Number of gilts/ growers	1.3	2.7	0.7	2.1	0.6	1.5	1.6	2.8
Improved breeds: Age of oldest female (months)	10.0	12.2	5.2	9.8	6.1	10.2	11.3	13.4
Local breeds: Number of sows	0.1	0.4	0.5	1.0	0.3	0.8	0.1	0.4
Local breeds: Number of boars	<0.1	0.3	0.1	0.4	0.1	0.3	<0.1	0.2
Local breeds: Number of gilts/growers	0.4	1.3	1.7	2.5	1.1	2.1	0.8	2.1
Local breeds: Age of oldest female (months)	18.6	7.0	21.5	8.8	19.8	7.3	15.3	3.8
Local breed sows with more than 1 parturition in the last year (count)	<0.1	0.3	0.2	0.6	0.1	0.5	<0.1	0.2

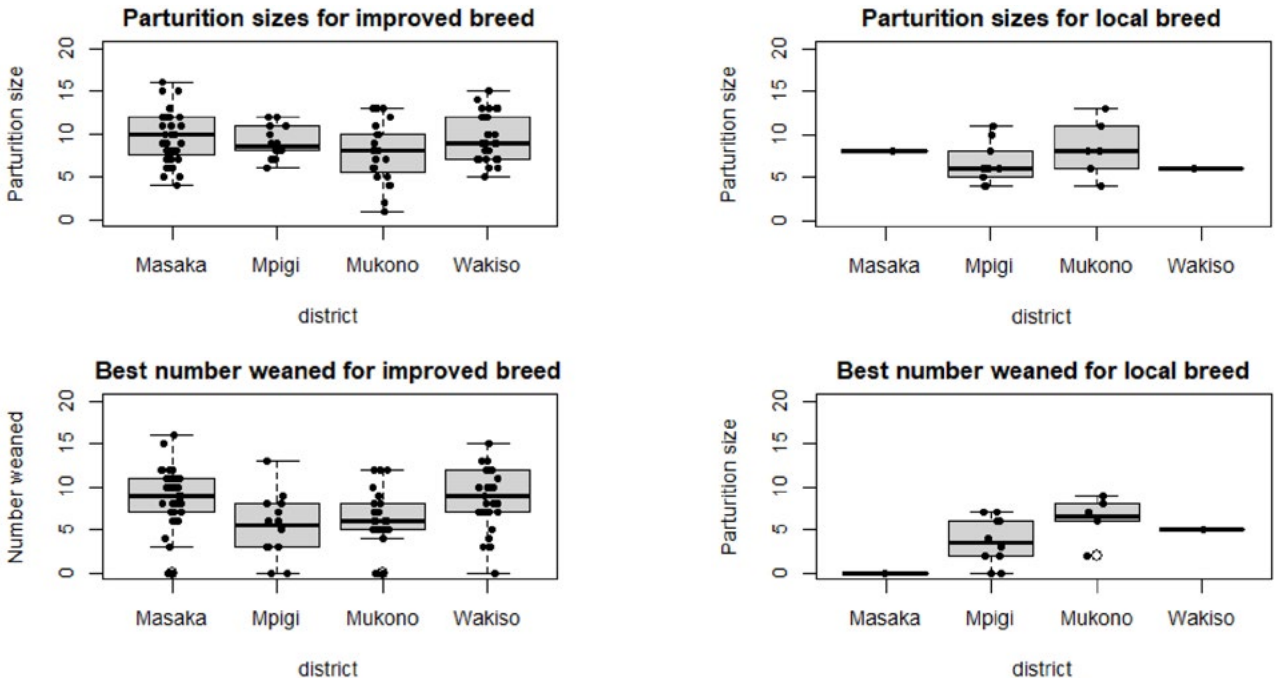
Photo ILRI/Kabir Dhanji

The best parturition size was around 9 in Masaka, Mpigi, and Wakiso, but slightly lower (around 8) in Mukono (**Table 13** and **Figure 12**). The worst parturition size was between around 6-8, with Mukono households again having the smallest litter size. The best gap between parturitions was smallest in Makasa (nearly once every six months), but largest (every 8.4 months) in Mukono. Households in Maska and Wakiso weaned the most number of piglets (**Table 13** and **Figure 12**).

Table 13. Births, parturitions, and weaning. NA values indicate a lack of data.

Breed	Indicator	Masaka		Mpigi		Mukono		Wakiso	
		mean	sd	mean	sd	mean	sd	mean	sd
Improved	Best parturition size (count)	7.0	11.2	5.7	8.9	5.3	7.5	12.5	17.7
	Worst parturition size (count)	6.7	26.7	5.0	16	4.4	8.0	8.9	16.3
	Best parturition gap (months)	0.1	0.6	0.2	4.3	<0.1	0.9	0.1	1.6
	Worst parturition gap (months)	855	5795	673	4738	577	1145	1481	3011
	Most piglets weaned (count)	855	5795	673	4738	577	1145	1481	3011
	Least piglets weaned (count)	855	5795	673	4738	577	1145	1481	3011
Local	Best parturition size (count)	7.0	11.2	5.7	8.9	5.3	7.5	12.5	17.7
	Worst parturition size (count)	6.7	26.7	5.0	16	4.4	8.0	8.9	16.3
	Best parturition gap (months)	0.1	0.6	0.2	4.3	<0.1	0.9	0.1	1.6
	Worst parturition gap (months)	855	5795	673	4738	577	1145	1481	3011
	Most piglets weaned (count)	855	5795	673	4738	577	1145	1481	3011
	Least piglets weaned (count)	855	5795	673	4738	577	1145	1481	3011

Figure 12. Boxplots displaying parturition sizes and number of piglets weaned, for the best performing sow of improved and local breeds.



Artificial insemination (AI) was not used frequently by households in any of the districts, usually by less than 10% of households. On average fewer than two pigs per household were serviced with AI (**Table 14**).

Not many adult pigs were purchased by households in the districts surveyed. More younger pigs were purchased (between 1.6 in Mpigi and 2.6 in Wakiso). Pigs tended to be sold to breeders as opposed to for slaughter (**Table 15**).

Table 14. Artificial insemination use by district.

	Masaka	Mpigi	Mukono	Wakiso
Pigs serviced with AI (count per HH)	1.8	1.3	1.5	2.2
Proportion of HH using AI (%)	7.6	3.1	10.1	4.0

Table 15. Pig purchases and sales by district.

Variable	Masaka		Mpigi		Mukono		Wakiso	
	mean	sd	mean	sd	mean	sd	mean	sd
Purchased sows (count)	0.2	0.5	0.1	0.2	0.1	0.1	0.1	0.2
Purchased boars (count)	0.1	1.0	<0.1	0.2	0	0	0.1	0.3
Purchased gilts/growers (count)	2.2	4.1	1.6	2.5	1.9	2.3	2.6	4.2
Sold adult breeding sows (count)	0.3	1.6	0.4	2.7	0.1	0.7	0	0
Sold breeding boars (count)	0.1	0.7	0.2	1.2	0.1	0.6	<0.1	0.1
Sold breeding gilt (count)	7.4	24.9	4.3	12.5	3.7	7.1	7.2	13.3
Sold sows for slaughter (count)	0.5	1.3	0.8	2.3	0.5	1.2	0.9	2.0
Sold boars for slaughter (count)	0.5	2.0	0.5	1.3	0.4	1.2	0.3	1.0
Sold weaners/gilts/growers slaughter (count)	1.5	3.4	1.2	2.6	0.8	1.6	2.6	6.9

Photo ILRI/Kabir Dhanji

A sow and her piglets in Kazinga village, Uganda.

PIG HEALTH

Around 40% of households in Masaka, Mpigi, and Mukono experienced disease in their pig herd over the past year. Only 23% of households in Wakiso had pigs that suffered from a disease in the past year (**Table 16**). Of the households that had at least one pig experience disease, the average proportion of the pigs owned by the households that experienced disease during the year was 60%. While only around 10% of households in Masaka, Mpigi, and Mukono had at least one pig die in their herd, this was up to 17% of households in Wakiso (Table 16). Slightly more young pigs died in Wakiso than the other districts (**Table 17**).

Table 16. Pig morbidity by district.

Disease	District			
	Masaka (% of hh)	Mpigi (% of hh)	Mukono (% of hh)	Wakiso (% of hh)
Morbidity (% HHs experiencing pig disease)	42	38	42	23
Proportion of pig herd that has had a disease (%)	58	53	68	63
Proportion of HH with at least one pig death (% HH)	11	11	9	17

Table 17. Pig deaths by age, sex, and district.

Disease	Masaka		Mpigi		Mukono		Wakiso	
	mean	sd	mean	sd	mean	sd	mean	sd
Sow deaths (count)	0.3	1.2	0.4	1.1	0.3	1.3	0.2	0.8
Boar deaths (count)	0.1	0.4	0.2	0.6	<0.1	0.2	0	0
Gilt/grower/weaner pig deaths (count)	1.3	5.2	2.4	5.0	1.4	3.8	2.7	5.6

African swine fever affected more households in Mpigi (42%) compared to households in the other districts (25%). Overall, gastro-related diseases tended to be the most prevalent type of diseases among households affecting between 30-55% of households. Respiratory diseases were also common in pig herds, especially in Mpigi and Mukono, but less so in Masaka and Wakiso. The category of "other" diseases generally constituted of diseases related to the skin, these were particularly prevalent in Mukono and Wakiso (**Table 18**).

Table 18. Summary of pig disease incidences by district.

Disease	District			
	Masaka (% of hh)	Mpigi (% of hh)	Mukono (% of hh)	Wakiso (% of hh)
African Swine Fever (AFS)	25	42	25	25
Gastro	54	52	31	40
Depression, inappetence, fatigue	9	22	11	15
Respiratory	8	31	14	6
Reproductive	3	5	1	1
Other (skin diseases)	23	25	71	81
None	16	11	4	1

The causes of death in the four districts were dominated by disease, accounting for between around 40-65% of pig deaths. Accidents were also important causes of pig deaths. While starvation was an important cause of death in Mpigi and Wakiso accounting for around 20-25% of pig deaths, it was the cause for only 11% of deaths in Mukono and 0% of deaths in Masaka (Table 19).

Table 19. Causes of pig death by district.

Cause of death	District			
	Masaka (% of deaths)	Mpigi (% of deaths)	Mukono (% of deaths)	Wakiso (% of deaths)
Disease	63	57	47	38
Starvation	0	21	11	24
Accident	25	21	32	14
Conflict	0	0	5	0
Unknown	4	0	5	10
Other	8	0	0	14

Photo ILRI/Kabir Dhanji

Manure management is one important biosecurity measure to keep diseases at bay from pigs.

PROJECT INTERVENTIONS

Project interventions were most commonly received by households in Masaka and Mpigi. One of the most popular project interventions received by households was deworming (by around 60% of households in Masaka and Mpigi, and 20-30% of households in Mukono and Wakiso). Record-keeping was also popular form of support in Makasa and Wakiso. Cooling animals to avoid heat stress was implemented by around 20% of households throughout the districts (**Figure 13**). Project interventions oriented toward livestock production were mainly directed toward pigs (**Table 20**).

Figure 13. Intervention types received by households, per district.

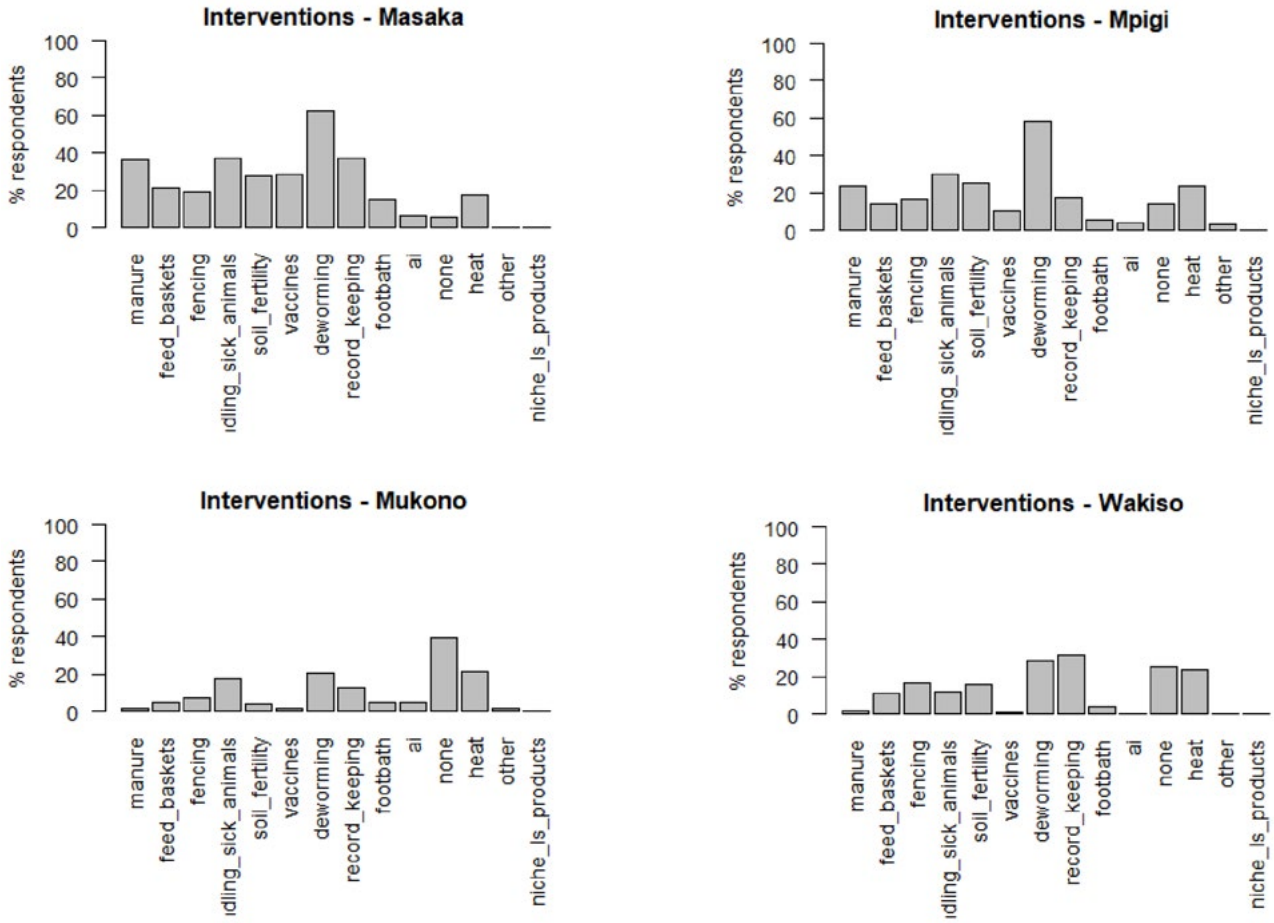


Table 20. Proportion of households practicing interventions by livestock species and district.

Intervention	Livestock species	Masaka (% HH)	Mpigi (% HH)	Mukono (% HH)	Wakiso (% HH)
AI	Goat	5	4	5	0
	Cattle	2	1	1	0
	Chicken	1	0	0	0
	Goat	–	–	–	–
Handling sick animals	Goat	36	30	17	12
	Cattle	4	5	4	0
	Chicken	16	10	4	1
	Goat	5	5	4	2
Heat stress mitigation	Goat	17	24	21	24
	Cattle	3	1	0	1
	Chicken	4	2	0	1
	Goat	0	2	0	1
Fencing	Goat	18	15	7	17
	Cattle	2	7	1	2
	Chicken	4	2	1	3
	Goat	1	5	1	0
Footbath	Goat	15	5	5	4
	Cattle	0	1	1	1
	Chicken	3	0	1	1
	Goat	0	1	0	0
Record-keeping	Goat	34	16	12	29
	Cattle	8	6	3	3
	Chicken	15	5	1	6
	Goat	4	2	2	3

The most common form of project intervention related to soil fertility improvements received by households in the four districts was animal manure management, received by around 20% of households. Mulching practices were also promoted by projects with support in this regard being received by around 20% of households too (**Figure 14**).

The degree to which respondents had increased use of interventions is shown in **Table 21**. The number of households using the techniques promoted by the intervention projects "more" or "much more" than before were greater in Masaka and Mpigi. Handling of sick animals, record keeping, and improved soil fertility techniques were techniques and management practices that were adopted more by households than compared to the past.

Figure 14. Proportion of households receiving different types of soil fertility interventions.

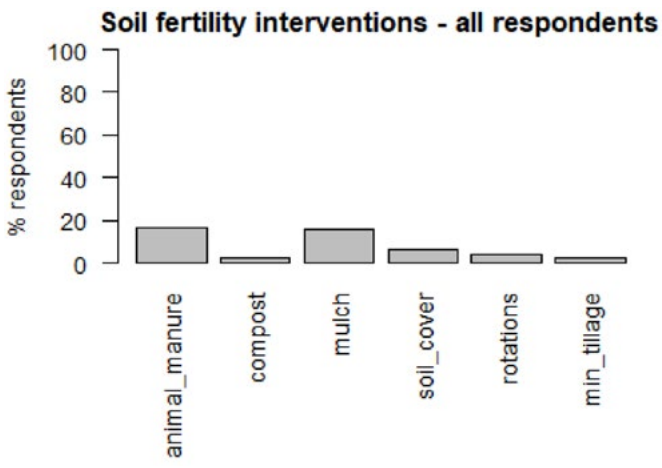


Table 21. Proportion of households using specific interventions "more" or "much more".

Intervention type	Masaka (% HH)	Mpigi (% HH)	Mukono (% HH)	Wakiso (% HH)
AI	3	3	3	0
Handling sick animals	34	20	17	12
Fencing	15	10	6	10
Footbath	14	2	3	2
Record keeping	33	12	10	26
Improved feedbaskets	19	14	4	6
Soil fertility techniques	24	21	3	13

More households shared technology innovations in the districts of Maska and Mpigi (63% and 51% of households respectively) than in the districts of Mukono and Wakiso (26% and 39% respectively). Overall, nearly 40% of households shared innovations with between 1-10 other households. The largest proportion of households (nearly 50%) were informed about the innovations through extension workers (**Figure 15**). Nearly 30% of households found out about the innovations through neighbours and family members. Agri-businesses and NGOs were other important sources of information accounting for 10% each of instances where households heard about the innovations.

Figure 15. Source of information for innovations.

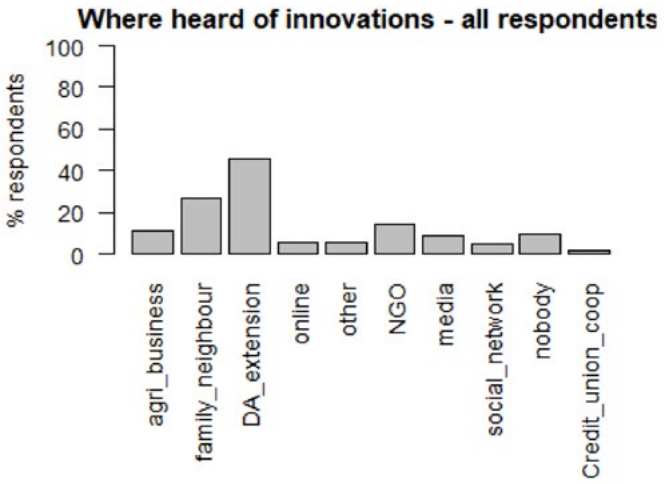


Photo ILRI/Kabir Dhanji

Checking for pregnancy.

Photo ILRI/Kabir Dhanji

SYNTHESIS AND CONCLUSIONS

Pigs on the move.

Pig-keeping households in four districts of central Uganda were surveyed, in order to provide a situation assessment and baseline for the More Pork project. Pig keeping was well established, and provided the major source of income amongst respondents, along with off farm activities, and a (usually) minor component of crop sales. On average households kept 5 to 10 pigs, although this was often as high as 20. Improved breeds were common, and they were generally bit more productive than local breeds, in terms of litter sizes and piglet survival (20-30% better). Artificial insemination was rare, and diseases were a major challenge, including gastro-intestinal diseases, skin diseases, and African swine fever. Markets for pig sales appeared to be well functioning, with weaners, growers, and gilts commonly bought and sold. The practices which the project intends to promote (artificial insemination, improved handling of sick animals, heat stress mitigation, improved fencing, record-keeping, and installation of footbaths) were already in existence but not widely practiced amongst respondents. Increased uptake of these practices and possible impacts on pig productivity could be assessed with future surveys. Impacts on household-level issues such as livelihoods or food security indicators could also be assessed using further surveys.

The households were poor, but not extremely poor. In the four districts, between 30 and 60% of households were below the 1.90 USD PPP poverty line. However, in three of the four districts the average cash income per person was 3 to 4 USD PPP, and in Mukono it was 1.7. Household economies were well diversified with the majority of farm produce sold, and 10 to 12 discrete sources of cash income reported on average. Food insecurity was present but was generally mild.

The two treatment districts and the two control districts were well matched. One of the treatment districts had more intensive pig production (Masaka), as did one of the control districts (Wakiso). Similarly, one of the treatment districts had less intensive pig production (Mukono), as did one of the control districts (Mpigi). The four districts therefore seem to set the basis for a useful comparison for the project activities going forwards.

Pork joint in Masaka, Uganda.
Photo ILRI/Kabir Dhanji

REFERENCES

Coates, J., Rogers B.L., Blau, A., Laurer, J., Roba, A. 2017. Filling a dietary data gap? Validation of the adult male equivalent method of estimating individual nutrient intakes from household-level data in Ethiopia and Bangladesh Food Policy, 72 (2017), pp. 27-42.

Dione, M. M., Dohoo, I., Ndiwa, N., Poole, J., Ouma, E., Amia, W.C., and Wieland, B. 2020. Impact of participatory training of smallholder pig farmers on knowledge, attitudes, and practices regarding biosecurity for the control of African swine fever in Uganda. *Transboundary and Emerging Diseases*. 00: 1-12. https://doi.org/10.1111/tbed.13587.

Jack, B. K. 2013. Constraints on the adoption of agricultural technologies in developing countries. White paper, Agricultural Technology Adoption Initiative, J-PAL (MIT) and CEGA (UC Berkeley).

Kimani, P. 2020. Addressing Uganda's pig value chain constraints, the PigSmart way. Blog on ILRI website: https://livelihoods-gender.ilri.org/2020/12/08/addressing-ugandas-pig-value-chain-constraints-the-pigsmart-way/.

Ouma, E., Dione, M., Birungi, R., Lule, P., Mayega, L., and Dizyee, K. 2018. African swine fever control and market integration in Ugandan peri-urban smallholder pig value chains: an ex-ante impact assessment of interventions and their interaction. *Preventive Veterinary Medicine*. 151 (29-39) doi: https://dx.doi.org/10.1016/j.prevetmed.2017.12.010.

Ouma, E., Roesel, K., Dione, M., Carter, N., Pezo, D., Ejobi, F., and Grace, D. 2014. Participatory Research for Development to Upgrade Smallholder Pig Value Chains in Uganda. Tropentag, September 17-19, 2014, Prague, Czech Republic "Bridging the gap between increasing knowledge and decreasing resources.

Processing feed.
Photo ILRI/Kabir Dhanji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