Prevalence and intensity of internal parasites in pigs under indigenous micro-organism (IMO) and conventional piggery farms, greater Mbarara, Uganda

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Abstract

A study on the prevalence and intensity of internal parasites in pigs under Indigenous Micro-organism (IMO) and conventional pig farming was conducted in Greater Mbarara, Uganda. The farmers kept Cambrough, Landrace and Large White cross breeds of pigs. The study was carried out in 6 farms (Katojo, Birongo, Ruti, Isingiro, Kwatotyo, Mbazardi) and adopted a cross sectional design. One hundred and forty eight (148) pigs were randomly selected irrespective of age and sex from the study area. The faecal samples from the pigs were processed for microscopic examination. The morphology and quantitative estimations of the ova, oocysts, and cysts per gram of faeces were done by applying the McMaster egg counting technique. The study established significant differences in the prevalence rates for *Hyostronglyus rubidus* under the two systems. Furthermore there were differences in the prevalence of *Dicrocaelium* spp., *Trichuris suis*, *Hyostronglyus rubidus* as well as the epg of *Ascaris suum* among the three age groups of pigs (piglets, growers and adults).

The prevalence of *Dicrocaelium* spp. in male pigs was significantly higher than for females. The overall prevalence of the endo-parasites particularly *Dicrocaelium* spp., *Hyostronglyus rubidus*and *Trichuris suis* as well as the epg for *Ascaris suum* were significantly different in the various farms and localities. Pigs of various age groups, sex and from different farms with mean epg>500 required urgent treatment against endo-parasites (*Trichuris suis*, *Hyostronglyus rubidus*) to reduce production losses. Overall, the study established that management system, the

age group, farm and location were risk factors to the prevalence of worms and their egg counts in rearing of pigs in Greater Mbarara.

Key Words: *breed of pigs, eggs per gram, management system, worms*

Introduction

In Uganda, pig farming is one of the fastest growing livestock enterprises that has become attractive throughout the country (Lagu et al 2009). Uganda has the largest pig production in East Africa. National statistics reveal that pig numbers in Uganda increased from 0.67 million in 1991, to 1.4 million in 1997; 1.6 million in 2001, to 2.3 million in 2005/06; 3.2 million in 2008 to 3.5 million in 2011 (UBOS 2007; UBOS 2012). It is therefore evident that the number of pigs is increasing steadily, and so is the number of households engaged in pig rearing.

However, the traditional housing structures for pig farming in Uganda are inadequate inadequate and are characterised by poor ventilation and spacing, inappropriate floor, and poor sanitation. These severely stress the pigs hence predisposing them to diseases. Pig production in Uganda is subject to several constraints, one of them being worm infections (Nissen et al 2011). In terms of management and pig health, the main constraints are poor housing and lack of knowledge on good management practices. African swine fever is ranked highest by farmers as the disease that causes high mortalities in pigs. A critical additional area is the presence of co-infestations with other porcine pathogens, including ecto-parasites and helminths which were identified as being endemic in pigs in Uganda (CGIAR 2014).

Although parasites of pigs are not well studied in Uganda and little documentation is available about their incidence, parasite infections are very common and cause severe productivity losses due to the poor growth of pigs as a result of poor feed use leading to loss of income (CGIAR 2013). It is therefore necessary to study these diseases and come up with proper and achievable measures to control them.

The desire to change the current environment of piggery production therefore resulted in the need to promote natural pig farming using Indigenous Micro-organisms (IMO) technology. Thistechnology has the following advantages: raising

pigs with no smell, no flies and no cleaning. Ability to decompose organic compounds, catalysis of chemical processes in the soil, natural ecosystems to facilitate recovery and suppression of diseases by circulating naturally active materials (Reddy 2011).

The major functions of IMO are; (i) decomposing complex organic compounds such as dead bodies of plants and animals and wastes into nutrients, making them easily absorbable, and (ii) creating compounds such as antibiotic substances, enzymes and lactic acids that can suppress various diseases and promote healthy soil conditions (Reddy 2011).

The pig housing technology achieves the desired impacts of eliminating smell, enabling IMO continuity with soil, use of natural ventilation and retaining heat. The use of a translucent corrugated iron sheet on the roof to concentrate the sunrays and produce heat in the litter inside the pig sty; unequal wall heights to leave space after roofing that facilitates expulsion of warm air out of the structure through the roof, one of the walls is shorter than the other.

Digging of a pit 30cm below the ground before pouring the saw dust litter. This pit covers the whole dimensions of the house and enables continuity of microorganism multiplication once the IMO solution is applied to the litter seeping down into the ground. To maximize the trapping of sun rays, the orientation of the building should be east-west so that the morning and evening sun is captured and utilized. Such solar positioning enables cooling and drying within the livestock housing (Reddy 2011).

A standard house measuring 4 metres by 3.5 metres can hold 15 pigs. For smaller numbers, these dimensions can be reduced accordingly. For larger numbers of pigs the dimensions can also be increased accordingly.

On the other hand conventional systems of pig rearing are characterized by indoor pig systems that allow the pigs' conditions to be monitored, ensuring minimum fatalities and increased productivity. Buildings are ventilated and their temperature regulated. The housing units are made of cement concrete floors. Manure can be managed through a waste-management system, though waste smell remains a problem which is difficult to manage.

However, there is barely published information on the relationship between the parasitic infection and management factors in piggery projects in Uganda. Considering these facts, this study determined the prevalence, intensity and

status of endo-parasites in relation to management systems, between IMO and conventional piggery management system.

Materials and methods

Study area

The study area was located in Greater Mbarara District, South Western Uganda. It is located between geographical coordinates 00^{o} 36' S, 30^{o} 36' E and covers an area of 1,846.4 km^{2}. It is situated at elevation 1422 meters above sea level (UBOS 2014). Greater Mbarara records bi-annual rainfall pattern in the months of February-May and September-December attaining a maximum annual average of 1200mm, humidity 80-90% and temperature range of 17-30 ^{o}C.

The district has hills and mountains, valleys as well as flat land with soils that are sandy, clay and laterite loam, appropriate for farming.

Study population

The study population consisted of pigs reared under conventional and IMO systems. The breeds were mainly cambrough, landrace and large white cross breeds. All age categories and both sexes viz. piglets, growers and adult pigs were targeted from six farms (Katojo, Birongo, Ruti, Isingiro, Kwatotyo, MbaZARDI).

Study design

The study adopted a cross sectional design. It was conducted in May 2016 to determine the prevalence and intensity of internal parasites in pigs at Indigenous Micro-organism (IMO) piggery farms and conventional farms in the study area. All farms practicing IMO technology in the greater Mbarara area were studied. Farms under the conventional system were enrolled in the study for comparison.

Sample size determination and sampling method

One eighty (180) pigs were earmarked from the study area irrespective of age and sex i.e. 60 piglets, 60 growers and 60 adults in both conventional and IMO systems each with 90 pigs. The age of the pigs were determined by farmers' recall. According to the age, the pigs were clustered into three groups, pigs under 2 months, were categorized as piglets, pigs in the range of 2-8 months, as growers and those which were 9 months and above, as adults. Pigs were further grouped as males and females. Previous studies in Uganda reported 80.3% and 91% prevalence of internal parasites in pigs (Wasswa et al 2007; Nissen et al 2011). This study considered an average (86%) of the two prevalence rates. The sample size was calculated based on the method described by (Thrusfield 2005) at 5 % acceptable error and 95% confidence level. However, 148 faecal samples were randomly picked from the various age groups representing 82.2 % of the targeted sample size. This was mainly because of lack of restraint infrastructure for the mature pigs at farm level. Furthermore, there was delay in timing of faecal sample collection from the pigs which had already voided their faeces and hence the field team missed feacal sample collection from such pigs. All the farmers interviewed had a positive response to the study.

Sample collection, transportation and preservation

The farm and pig profiles were recorded on the data sheets i.e. location of the farm, pig identification number, sex and age of the pigs, management system and frequency of deworming.

Freshly voided faecal samples from pigs were collected taking into account hygienic measures such as wearing of hand gloves, gumboots, to avoid contamination. Each sample was kept in separate plastic faecal sample bottles. These were further kept in polythene bags which were carefully tied and labeled. The samples were then brought to Regional Mbarara District Veterinary Office Laboratory and stored in a cold chain facility of $4^{o}C$ until all the samples were examined.

The faecal samples were processed for microscopic examination, particularly focusing on ova, cysts, and oocysts of different parasites. Oocysts per gram of faeces were determined by applying the McMaster Egg Counting technique (Georgi and Theodorides 1980; Jørgen and Brian 1994; Urquhart et al 1996).

Quantitative worm egg determination using McMaster technique

Approximately 4 g of faeces were placed in container 1. Flotation fluid (56ml) was added into it. The mixture was stirred thoroughly with a stirring rod and filtered through a double-layer cheese cloth to remove the solid faecal material from the filtrate which was then transferred into container 2. The filtrate was stirred and a sub-sample was picked with a Pasteur pipette to fill the McMaster counting chamber. This was allowed to stand for 5 minutes. The subsamples were then examined under a light microscope at a 10 x 10 magnification. All the eggs and coccidian oocysts in the engraved area of both chambers were counted. The number of eggs per gram were calculated by adding the egg counts of the two chambers together and multiplied by a factor of 50 to give the total egg count per gram (epg) of faeces.

Data analysis

All the data collected were entered into Microsoft Excel 2007 and exported to SPSS 20 for analysis. Descriptive and inferential statistics were computed capturing farm and pig profiles. The prevalence of infestation of the pigs under conventional and IMO systems was determined by the number of animals infested compared to the total number of pigs in the population. Risk factors associated with the occurrence of the internal parasites were analyzed and their significant relationships/ differences established using chi-square (χ^2), student 't' and ANOVA F tests at 5 % level of significance.

Results

The profile of the farms, pigs and management system studied are presented in Table 1. The management system, age groups of the pigs, feeding system and the deworming status of the pigs are illustrated as well as the introduction of new pigs into the farm. The farmers practiced conventional pig rearing system and introduced indigenous Micro-organism (IMO) system, where pigs are reared indoor in both systems with differing housing, feeding, watering and hygiene practices.

In some other circumstances, farmers collected digesta from rumen of slaughtered animals from abattoirs and fed them to the pigs especially in the conventional farming system.

It was observed that generally, pigs were routinely dewormed between 2-3 months interval in both IMO and Conventional systems. In some farms deworming was after 3- 4 months interval. The preferred choice of dewormers in use was the subcutaneous Ivermectin injection which targeted both internal and external parasites like lice (*Haematopinus suis*), fleas (*Ctenocephalides* spp) and mites (*Sarcoptes scabiei* var. suis, *Demodex phylloides*).

Table 1. Profile of the farms, pigs and management system

Categories	Sex		Total	Management	Feeding system	Deworming status	Introduction of new pigs
	M	F					
IMO							
Piglets	15	15	30	IMO system	Maize bran, greens and brewers waste	Last dewormed a month ago with Ivermectin injectable	No new pigs were introduced during the study
Growers	15	15	30				
Adults	15	15	30				
Conventional							
Piglets	15	15	30	Conventional system	Maize bran, greens and brewers waste	Last dewormed a month ago with Ivermectin'	No new pigs were introduced during the study
Growers	15	15	30				
Adults	15	15	30				
Total	**90**	**90**	**180**				

Overall prevalence and epg of endo-parasites of pigs

During the study period, the overall prevalence of endo-parasites in pigs was 72.3 % and epg ranging from 50-14,500.Ten parasite types were identified as detailed in Table 2. It was noted that between 1-4 parasite species co-existed with one another in the same pig.

Table 2. Overall prevalence and burden of endo-parasites of pigs at study sites (N =148)

Parasites	Count (n)	Prev. (%)	EPG	
			Range	Mean±SE
Dicrocaelium spp.	56	37.8	50-1450	392±37
Hyostronglyus rubidus	45	30.4	50-3400	432±100
Trichuris suis	15	10.1	50-14300	1283±940

Globecephalus spp.	10	6.80	50-250	85±20
Ascaris suum	5	3.40	50-350	140±56
Fasciola spp.	3	2.00	50-50	50±0
Macracanthorhynchus hirudinaceus	3	2.00	50-50	50±0
Strongloides spp.	2	1.40	50-100	75±25
Metastronglus spp.	1	0.70	100-100	100±0
Trichostrongylus spp.	1	0.70	50-50	50±0
Others unknown	6	4.10	50-500	208±86
Overall	**107**	**72.3**	**50-14500**	**599±144**

N = total number of pig faecal samples collected, n = number of infected faecal samples, Prev. = prevalence

Prevalence and epg of endo-parasites of pigs under Conventional and IMO systems

It was observed that there was a significant difference in the prevalence rates for *Hyostronglyus rubidus* in pigs kept under the Indigenous Micro-organism system compared to conventional systems (Table 3).

Table 3. Prevalence of endo-parasites of pigs under IMO and Conventional systems

Parasites	**IMO system (N=73)**		**Conventional system (N=75)**		χ^2 **2df)**	***p* -value**
	Count (n)	**Prev. (%)**	**Count (n)**	**Prev. (%)**		
Dicrocaelium spp.	33	45.2	23	30.7	3.33	0.07
Hyostronglyus rubidus	14	19.2	33	44.0	8.58	0.00
Trichuris suis	6	8.20	9	12.0	0.58	0.45
Globecephalus spp.	4	5.50	6	8.00	0.37	0.54
Ascaris suum	3	4.10	2	2.70	0.24	0.63
Strongloides spp.	0	0	2	2.70	1.97	0.16
Fasciola spp.	2	2.70	1	1.30	0.37	0.54
Macracanthorhynchus hirudinaceus	2	2.70	1	1.30	0.37	0.54
Metastronglus spp.	0	0	1	1.30	0.98	0.32
Trichostrongylus spp.	0	0	1	1.30	0.98	0.32
Others unknown	2	2.70	4	5.30	0.64	0.42
Overall	**49**	**67.10**	**58**	**77.3**	**1.93**	**0.17**

N = total number of pig faecal samples collected, n = number of infected faecal samples, Prev. = prevalence

The mean EPG was the highest for *Trichuris suis* under conventional system compared to IMO.

Table 4. EPG of endo-parasites of pigs under IMO and Conventional systems

Parasites	**IMO (N=73)**			**Conventional (N=75)**			**t**	***p* - value**
	n	**Range**	**Mean±SE**	**n**	**Range**	**Mean±SE**		
Hyostronglyus rubidus	14	50-1900	407±146	33	50-3400	444±131	-0.17	0.87
Dicrocaelium spp.	33	50-900	345±40	23	50-1450	459±67	-1.54	0.13
Ascaris suum	3	50-350	150±100	2	100-150	125±25	0.19	0.86
Trichuris suis	6	50-350	133±54	9	50-14300	2050±1547	-1.00	0.34
Globecephalus spp.	4	50-100	75±14	6	50-250	92±33	-0.39	0.71
Strongloides spp.	0	-	-	2	50-100	75±25	-	-
Fasciola spp.	2	50-50	50±0	1	50	50	-	-
Macracanthorhynchus hirudinaceus	2	50-50	50±0	1	50	50	-	-
Trichostrongylus spp.	0	-	-	1	50	50	-	-
Metastronglus spp.	0	-	-	1	100	100	-	-
Others unknown	2	150-500	325±175	4	50-450	150±100	0.95	0.40
Overall	**49**	**0-1900**	**267±39**	**58**	**0-14500**	**595±206**	**-1.54**	**0.13**

n = *total number of pig faecal samples collected, n = number of infected faecal samples*

Age related prevalence and epg of endo-parasites of pigs

In the study, it was found that the overall prevalence of endo-parasites were not significantly different in the three age groups (Table 5). There were statistically significant differences in the prevalence of *Dicrocaelium* spp., *Trichuris suis*, *Hyostronglyus rubidus* among the three age groups i.e. piglets, growers, and adult pigs under IMO and Conventional systems.

Table 5. Prevalence of endo-parasites of pigs under the various age groups

Parasites	Piglet (N=40)		Grower (N=57)		Adult (N=51)		χ^2 (2df)	*p* - value
	Count (n)	Prev. (%)	Count (n)	Prev. (%)	Count (n)	Prev. (%)		
Dicrocaelium spp.	18	45.0	34	59.6	4	7.80	31.91	0.00
Trichuris suis	10	25.0	2	3.50	3	5.90	13.47	0.00
Hyostronglyus rubidus	9	22.5	11	19.3	25	49.0	12.86	0.00
Globecephalus spp.	3	7.50	3	5.30	4	7.80	0.33	0.85
Ascaris suum	2	5.00	2	3.50	1	2.00	0.64	0.73
Trichostrongylus spp.	1	2.50	0	0	0	0	2.72	0.26
Metastronglus spp.	0	0	1	1.80	0	0	1.61	0.45
Strongloides spp.	0	0	0	0	2	3.90	3.86	0.15
Fasciola spp.	0	0	3	5.30	0	0	4.89	0.09
Macracanthorhynchus hirudinaceus	0	0	2	3.50	1	2.00	1.46	0.48
Others unknown	0	0	4	7.00	2	3.90	2.98	0.23
Overall	**28**	**70.0**	**46**	**80.7**	**33**	**64.7**	**3.58**	**0.17**

N = total number of pig faecal samples collected, n = number of infected faecal samples, Prev. = prevalence

The study found that there was a significant difference in the epg of *Ascaris suum* among piglets, growers and adult pigs (Table 6).

Table 6. EPG of endo-parasites of pigs under the various age groups

Parasites	Piglet (N=40)			Grower (N=57)			Adult (N=51)			F	*p* -value
	n	Range	Mean±SE	n	Range	Mean±SE	n	Range	Mean±SE		
Trichuris suis	10	50-14300	1845±1398	2	50-600	325±275	3	50-50	50±0	0.33	0.73
Hyostronglyus rubidus	9	50-3400	500±363	11	50-900	232±80	25	50-2300	496±122	0.64	0.53
Dicrocaelium spp.	18	50-1450	403±90	34	50-900	390±38	4	200-500	363±69	0.04	0.96
Globecephalus spp.	3	50-250	133±60	3	50-100	67±17	4	50-100	63±13	1.39	0.31
Ascaris suum	2	100-150	125±25	2	50-50	50±0	1	350	350	48.60	0.02
Trichostrongylus spp.	1	50	50	0	-	-	0	-	-	-	-
Metastronglus spp.	0	-	-	1	100	100	0	-	-	-	-

Strongloides spp.	0	-	-	0	-	-	2	50-100	75±25	-	-
Fasciola spp.	0	-	-	3	50-50	50±0	0	-	-	-	-
Macracanthorhynchus hirudinaceus	0	-	-	2	50-50	50±0	1	50	50	-	-
Others unknown	0	-	-	4	50-500	188±107	2	50-450	250±200	0.10	0.77
Overall	**28**	**50-14500**	**1104±533**	**46**	**50-900**	**388±34**	**33**	**50-2350**	**464±95**	**1.90**	**0.15**

N = total number of pig faecal samples collected, n = number of infected faecal samples

Sex related prevalence and epg of endo-parasites of pigs

(Table 7). The prevalence of *Dicrocaelium* spp. in male pigs was significantly higher than for females.

Table 7. Prevalence of endo-parasites of pigs under the sex groups

Parasites	**Female (N=96)**		**Male (N=52)**		χ^2 **(1df)**	***p***
	Count (n)	**Prev. (%)**	**Count (n)**	**Prev. (%)**		
Hyostronglyus rubidus	32	33.3	13	25.0	1.11	0.29
Dicrocaelium spp.	30	31.3	26	50.0	5.04	0.03
Trichuris suis	7	7.30	8	15.4	2.43	0.12
Globecephalus spp.	6	6.30	4	7.70	0.11	0.74
Ascaris suum	2	2.10	3	5.80	1.40	0.24
Macracanthorhynchus hirudinaceus	2	2.10	1	1.90	0.00	0.95
Metastronglus spp.	1	1.00	0	0	0.55	0.46
Strongloides spp.	1	1.00	1	1.90	0.20	0.66
Fasciola spp.	1	1.00	2	3.80	1.34	0.25
Trichostrongylus spp.	0	0	1	1.90	1.86	0.17
Others unknown	5	5.20	1	1.90	0.94	0.33
Overall	**65**	**67.7**	**42**	**80.8**	**2.87**	**0.090**

N = total number of pig faecal samples collected, n = number of infected faecal samples, Prev. = prevalence

Table 8. EPG of endo-parasites of pigs under the sex groups

Parasites	Female (N=96)			Male (N=52)			t	*p*
	n	Range	Mean±SE	n	Range	Mean±SE		
Dicrocaelium spp.	30	50-1450	413±57	26	50-850	367±44	0.62	0.54
Hyostronglyus rubidus	32	50-2300	384±94	13	50-3400	550±263	-0.75	0.50
Metastronglus spp.	1	100	100	0	-	-	-	-
Trichuris suis	7	50-250	86±28	8	50-14300	2331±1726	-1.21	0.25
Globecephalus spp.	6	50-100	75±11	4	50-250	100±50	-0.60	0.57
Ascaris suum	2	50-50	50±0	3	100-350	200±76	-1.52	0.23
Strongloides spp.	1	50	50	1	100	100	-	-
Fasciola spp.	1	50	50	2	50-50	50±0	-	-
Macracanthorhynchus hirudinaceus	2	50-50	50±0	1	50	50	-	-
Trichostrongylus spp.	0	-	-	1	50	50	-	-
Others unknown	5	50-500	500	1	150	150	0.27	0.80
Overall	**65**	**50-2350**	**419±54**	**42**	**50-14500**	**876±357**	**-1.91**	**0.06**

N = total number of pig faecal samples collected, n = number of infected faecal samples

Farm related prevalence and epg of endo-parasites of pigs

The overall prevalence of the endo-parasites was different in the study locations (Table 9) particularly *Dicrocaelium spp.,Hyostronglyus rubidus* and *Trichuris suis*.

Table 9. Prevalence of endo-parasites of pigs in the different farms

Parasites	Katojo N=22)		Birongo (N=15)		Ruti (N=25)		Isingiro (N=45)		Kwatotyo (N=18)		MbaZARDI (N=23)		χ (5df)
	Count (n)	Prev. (%)	Count (n)	Prev. (%)	Count (n)	Prev. (%)	Count (n)	Prev. (%)	Count (n)	Prev. (%)	Count (n)	Prev. (%)	
Dicrocaelium spp.	0	0	0	0	0	0	41	91.1	15	83.3	0	0	121.88
Hyostronglyus rubidus	2	9.1	9	60.0	18	72.0	3	6.70	0	0	13	56.5	58.63
Trichuris suis	3	13.6	0	0	3	12.0	3	6.70	0	0	6	26.1	11.13
Metastronglus spp.	0	0	0	0	1	4.00	0	0	0	0	0	0	4.95

Globecephalus spp.	2	9.1	1	6.7	3	12.0	1	2.20	0	0	3	13.0	5.50
Ascaris suum	1	4.5	0	0	0	0	2	4.40	0	0	2	8.70	4.27
Strongloides spp.	0	0	0	0	2	8.00	0	0	0	0	0	0	9.98
Fasciola spp.	0	0	0	0	1	4.00	2	4.40	0	0	0	0	3.43
Macracanthorhynchus hirudinaceus	0	0	0	0	0	0	3	6.70	0	0	0	0	7.01
Trichostrongylus spp.	0	0	0	0	0	0	0	0	0	0	1	4.30	5.47
Others unknown	0	0	1	6.7	1	4.0	4	8.90	0	0	0	0	5.63
Overall	**6**	**27.3**	**9**	**60.0**	**19**	**76.0**	**43**	**95.6**	**15**	**83.3**	**15**	**65.2**	**37.40**

N = total number of pig faecal samples collected, n = number of infected faecal samples, Prev. = prevalence

The overall epg ranges for endo-parasites in the various farms are detailed in Table 10. There was statistically significant difference in the epg for *Ascaris suum* in the different farms.

Table 10. EPG of endo-parasites of pigs in the different farms

Parasites	**Katojo (N=22)**			**Birongo (N=15)**			**Ruti (N=25)**			**Isingiro (N=45)**			**Kwatotyo (N=18)**			**MbaZAI**	
	n	**Range**	**Mean±SE**	**n**	**Range**	**Mean±SE**	**n**	**Range**	**Mean±SE**	**n**	**Range**	**Mean±SE**	**n**	**Range**	**Mean±SE**	**n**	**Rang**
Dicrocaelium spp.	0	-	-	0	-	-	0	-	-	41	50-900	359±33	15	50-1450	483±100	0	-
Hyostronglyus rubidus	2	150-250	200±50	9	50-1900	589±196	18	50-2300	481±143	3	50-100	83±17	0	-	-	13	50-34
Globecephalus spp.	2	100-100	100±0	1	100	100	3	50-50	50±0	1	50	50	0	-	-	3	50-25
Metastronglus spp.	0	-	-	0	-	-	1	100	100	0	-	-	0	-	-	0	-
Trichuris suis	3	50-50	50±0	0	-	-	3	50-600	233±183	3	50-350	217±88	0	-	-	6	50-14
Ascaris suum	1	350	350	0	-	-	0	-	-	2	50-50	50±0	0	-	-	2	100-1
Strongloides spp.	0	-	-	0	-	-	2	50-100	75±25	0	-	-	0	-	-	0	-
Fasciola spp.	0	-	-	0	-	-	1	50	50	2	50-50	50±0	0	-	-	0	-
Macracanthorhynchus hirudinaceus	0	-	-	0	-	-	0	-	-	3	50-50	50±0	0	-	-	0	-
Trichostrongylus spp.	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	1	50-50
Others unknown	0	-	-	1	50	50	1	50	50	4	50-500	288±111	0	-	-	0	-
Overall	**6**	**50-350**	**183±42**	**9**	**50-1900**	**606±193**	**19**	**50-2350**	**518±134**	**43**	**50-1000**	**399±33**	**15**	**50-1450**	**483±100**	**15**	**50-14**

N = total number of pig faecal samples collected, n = number of infected faecal samples

Discussion

The management practices viz; housing, feeding, watering and hygiene practices are part and partial of the indigenous Micro-organism (IMO) and conventional systems. During the study period, there was no evidence that pigs were brought in from elsewhere under the two rearing systems. Hence the co-existence of 1-4 endo-parasite species in the same pig in this study is associated with indoor rearing of the pigs under the two management systems. This is in agreement with findings of previous studies (Smith et al 1982; Nansen and Roepstorff 1999) which found out that indoor rearing of pigs narrows the parasite spectrum to only 1-4 species co-existing in permanently indoor piggeries.

The overall prevalence of endo-parasites of pigs of 72.3% in Mbarara, south western Uganda was slightly lower than that reported by Nissen et al (2011) in Kabale, south western Uganda of 91%, Waiswa et al (2007) in South Eastern Uganda of >87%, and Kagira et al (2008) in Kenya of 84.2% but higher than prevalences obtained by Nganga et al (2008) in Kenya, Esrony et al (1997) in Tanzania, Abdu and Gashaw (2010) in Holeta, Ethiopia and Keshaw et al (2009) in the West Indies of 67.8%, 53%, 30.4%, and 68.78% respectively. The high prevalence of the endo-parasites in Mbarara, south western Uganda is in agreement with Nissen et al (2011) who reported that nematode infections are very common in pigs kept in South Western part of Uganda.

Jufare et al (2015) attribute the variations in the prevalences of pig endo-parasites in various countries to differences in management systems, breed of pig, age, nutrition, animal health extension services and local ecological factors (humidity, temperature, rainfall, soils) in those countries. Our findings attribute the prevalence rate among the pigs in various farms to management system, nutrition and availability of veterinary extension services.

The prevalence of various helminthes in pigs were the highest for *Dicrocaelium* spp. followed by *Hyostronglyus rubidus,Trichuris suis, Globecephalus* spp. and *Ascaris suum* (Table 2). According to Caballero-Hernández et al (2004), Kagira et al (2008), Nganga et al (2008), *Strongylus* spp., *Trichuris suis,* and *Ascaris suum* are some of the most common gastrointestinal (GIT) parasites of pigs worldwide.

The prevalence of *Hyostronglyus rubidus* (30.4%) in the study area was slightly lower than prevalence of strongyle ova/eggs obtained in Kabale, Uganda by Nissen et al (2011), Kenya by Kagira et al (2008) and in the West Indies

(Keshaw et al 2009) of 89%, 37% and 44%, respectively but higher than that found in Zimbabwe (Marufu et al. 2008) of 14% where*Hyostrongylus rubidus* was among the common strongyles identified. *Ascaris suum* found at a prevalence of 3.4% was lower than prevalences of *Ascaris suum* reported by Nissen et al (2011) in Kabale, Uganda and Jufare et al (2015) in Bishoftu, Ethiopia of 40% and 4.9% respectively. The variations in prevalence figures from different locations were possibly due to differences in management systems and local ecological factors.

The prevalence of *Trichuris suis* (10.1%) in this study was lower than prevalence of *T. suis* (17%) reported by Nissen et al (2011) in Kabale district also in south western Uganda. The prevalence of *T. suis* in the West Indies of 38% (Keshaw et al 2009) was even much higher than that of *Trichuris suis* in the current study. However lower prevalence of *Trichuris suis* was recorded in this study than prevalences of *T. suis* found by Zewdneh et al (2013) in Tigrai (Ethiopia), Kagira et al(2008) in Kenya, Marufu et al (2008) in Zimbabwe, Permin et al (1999) in Ghana, and Weng et al(2005) in China of 0.3%, 7%, 4.7%, 4.6% and 5.2%, respectively. The variations in prevalence rates can also be attributed to similar reasons of management systems and local ecological factors.

Although, cases of *Dicrocaelium* spp. are rare in pigs, in this study the prevalence of *Dicrocaelium* spp. was the highest compared to other endo-parasites. This was because farmers harvest and feed infected grass pastures as green herbage to the pigs to minimize commercial feed costs. The pigs therefore become incidental hosts to the infection (Soulsby 1968; Urquhart et al 1996). Snails in most of the multiplication sites multiply fast with minimum efforts from farmers to use molluscicides to kill the vectors. Even when pastures are cleaned, re-infection occurs very fast and when pastures are harvested and given to pigs, infection occurs.

Hyostrongylus rubidus has a **direct life cycle**. After shedding, the eggs release the larvae in the environment, which develop to infective L_3 -larvae in about 5 days, better outdoors in humid pastures, than indoors. They are not very resistant to dryness and cool temperatures. Pigs of any age become infected after ingesting such larvae, but piglets are usually more exposed and susceptible (Soulsby 1968; Urquhart et al 1996).

The egg-shedding peaks of *Hyostrongylus rubidus* is during lactation and consequently lactating sows are more at risk of becoming infected. Systematic and thorough removal of all manure and keeping the facilities dry reduces the risk of infection. Since development of eggs to infective L3-larvae takes at least 5 days, removing all manure in shorter intervals can break the life cycle and reduce the infectivity of the environment. In our study the prevalence of 30.4% is

attributed to delay in removal of pig faecal materials and failure under the management system to keep the moisture low in the pig sties.

Trichuris suis had a prevalence of (10.1%). In dry and hygienic environments this worm is of little significance but in poor conditions it can become a major pathogen. In many farms, moist and unhygienic conditions are the most probable reasons for the occurrence of the parasite (Soulsby 1968; Urquhart et al 1996; Kahn, 2013).

Globecephalus spp. have a **direct life cycle** without intermediate hosts. Eggs shed with the feces of the infected host release larvae in the environment (also indoors!) that develop to infective L_3-larvae in 8 to 12 days. These infective larvae are not very resistant in the environment: they do not support direct sunlight, dryness and low temperatures. Usually they do not survive long periods at temperatures below 0°C (Soulsby 1968; Urquhart et al 1996).

These worms attach to the gut's mucosa to suck blood and change frequently the attachment site. This causes numerous small bleedings and lesions in the mucosa. Digestion is disturbed (reduce weight gains or even weight loss) with anemia and hypoproteinaemia (Soulsby 1968; Urquhart et al 1996). The prevalence of 6.8% is attributed to favourable environmental conditions of moisture and temperatures in addition to unhygienic conditions and contamination of feeds.

Ascaris suum has adirect life cycle, i.e. there are no intermediate hosts. Adult females lay 1 million eggs and more daily, which are shed with the feces. These eggs are extremely resistant to dryness, freezing and disinfectants, and can remain infective in the environment for five years and beyond. This means that in most pig production facilities the environment is very likely to be contaminated with *Ascaris suum* eggs. Sunlight and persistent dryness will kill the eggs. The prevalence of 3.4 % in this study was due to favourable environmental conditions, contamination and unhygienic practices in the piggery farms.

The mean egg per gram for *Hyostronglyus rubidus* (432) and *Ascaris suum*(140) in this study were lower than mean epg for Strongyle (964) and *Ascaris suum* (4,673) obtained by Nissen et al (2011) in Kabale, Uganda.On the other hand, the mean epg of *Trichuris suis*(1283) for this current study was much higher than the mean epg of *Trichuris suis* (264) obtained by Nissen et al (2011).Wasswa et al (2007) identified Strongyle eggs as one of the most common eggs in pigs of South Eastern Uganda. Urquhart et al (1996) observed that sporadic disease caused by heavy infestation

by *T. suis* is more common in pigs associated with the longevity in the environment of the eggs of *Trichuris suis* which can be up to 3 or 4 years. This explains the very high mean egg per gram (1283) for *Trichuris suis* than for the other helminthes. According to Roepstorff and Nansen (1998), the thick-shelled eggs of *A. suum* are also resistant to adverse environmental factors as well as chemicals and can maintain infectivity for long periods of time and that partly explains the relatively high mean egg per gram of *Ascaris suum* (140) in this study.

Low egg counts (e.g., 100-200 epg) usually signify false-positive counts associated with intestinal passage (coprophagia) of unembryonated eggs emanating from infected penmates (Eriksen et al 1992; Bindseil, 1974). Hence false-positive counts have been recorded for endo-parasites with low egg counts under the following management systems, age groups, sexes and farms: *Ascaris suum*, *Globecephalus* spp.,*Strongloides* spp., *Fasciola* spp.,*Macracanthorhynchus hirudinaceus*, *Trichostrongylus* spp., *Metastronglus* spp. under both IMO and conventional management systems and *Trichuris suis* under IMO. *Globecephalus* spp., *Ascaris suum*, *Trichostrongylus* spp.,*Metastronglus* spp., *Strongloides* spp. and *Fasciola* spp. in piglets, growers and adult piglets.

False-positive counts were also recorded for *Metastronglus* spp., *Globecephalus* spp., *Ascaris suum*, *Strongloides* spp., *Fasciola* spp., *Macracanthorhynchus hirudinaceus* and *Trichostrongylus*spp. in both female and male pigs and *Trichuris suis* in female pigs. *Hyostronglyus rubidus*, *Globecephalus* spp., and *Trichuris suis* in pigs at Katojo farm; *Globecephalus* sp, *Metastronglus* spp., *Strongloides* spp. and *Fasciola* spp. in Ruti farm; *Hyostronglyus rubidus, Globecephalus* spp., *Ascaris suum*, *Fasciola* spp. and *Macracanthorhynchus hirudinaceus* in Isingiro farm; *Globecephalus* spp. , *Ascaris suum* and *Trichostrongylus* spp. in MbaZARDI farm. The studies proved that false-positive egg counts are common in pigs as a result of coprophagy or geophagy (Boes et al 1997, 1998a). Therefore, results of false-positive egg counts may imply exposure of pigs to pig faeces containing eggs (Nissen et al 2011).

Furthermore, Wasswa et al (2007) recommended pigs with epg>500 should receive treatment if production losses are to be avoided. Therefore pigs under conventional system, piglets, male pigs, pigs in Birongo, Ruti and MbaZARDI farms with mean epg>500 required treatment to reduce production losses. Specific endo-parasites from which the pigs needed treatment include: *Trichuris suis* under conventional system; *Trichuris suis* and *Hyostronglyus rubidus* in

piglets;*Hyostronglyus rubidus* and *Trichuris suis* in male pigs; *Hyostronglyus rubidus* in Birongo farm and *Trichuris suis* in MbaZARDI farm.

The overall prevalences of the endo-parasites under the two indoor pig management systems i.e. IMO system with saw dust floor (67.1%) and conventional system with concrete floor (77.3%) were not different in the two management systems though the prevalence rates tended to be higher in both systems. This is probably due to unhygienic practices and inadequate deworming under these two management systems. The high prevalence of endo-parasites in conventional system with concrete floor in this study is contrary to the findings of Waiswa et al (2007) that helminthosis in pigs is rare in farms where the pigs are kept on concrete floors for most of the time. The authors further assert that helminthosis is rare in farms where the pigs are subjected to routine parasite control programmes rather than housing as a factor.

The trend ($p=0.15$) for a difference in the overall prevalence of endo-parasites in pig of the various age groups (grower, piglet, adult) agrees with the fact that parasitic infections in pigs in Africa are major constraints to efficient pig production of all age groups (Hale et al 1986; Permin et al 1999; Sangeeta et al 2002). However the prevalence was slightly higher in growers (80.7%) followed by piglets (70.00%) and lastly adults (64.71%). Jufare et al (2015) in their study of parasites of pigs in Ethiopia also found slightly higher occurrence of parasitic infestation in grower pigs (29.7%) than in piglets (19.9%) and adult pigs (23.1%). However, the slightly higher prevalence of the endo-parasites in piglets than the adult pigs is contrary to the findings of Jufare et al (2015).

The differences in the overall prevalence of endo-parasites, prevalence of *Dicrocaelium* spp., *Hyostronglyus rubidus* and *Trichuris suis* as well as epg for *Ascaris suum* in the different farms could be attributed to use of differing pig husbandry practices including feeding, frequency of deworming and housing under the indigenous Micro-organism (IMO) and conventional systems. This is in agreement with the findings of Nissen et al (2011) who established that significantly lower prevalence of strongyle infections and lower mean strongyle faecal egg counts occur in pigs reared on wooden slatted floors.

Conclusions

- Generally there was no superiority of either of the two systems (IMO and conventional) as far as worm prevalence and egg counts were concerned but rather worm burden was possibly precipitated by variations in husbandry practices (housing, feeding, watering and hygiene).

- The study established differences in the prevalence rates for *Hyostronglyus rubidus* under the two systems. Furthermore there were differences in the prevalence of*Dicrocaelium* spp., *Trichuris suis, Hyostronglyus rubidus* as well as the epg of *Ascaris suum* among the three age groups of pigs (piglets, growers, and adult).

- Additionally the prevalence of *Dicrocaelium* spp. in male pigs was higher than for females. The overall prevalence of the endo-parasites particularly *Dicrocaelium* spp., *Hyostronglyus rubidus* and *Trichuris suis*, as well as the epg for *Ascaris suum*, were different in the various farms and localities.

- Overall, the study established that management system, age, farm and location were risk factors to the prevalence of worms and their egg counts in rearing of pigs in Greater Mbarara.

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