MAKERERE UNIVERSITY

EVALUATION OF REPRODUCTIVE PERFORMANCE OF BREEDING SOWS WITHIN SELECTED PARISHES OF MAKINDYE DIVISION, KAMPALA DISTRICT

BY

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DECLARATION

I, **KYEYUNE PETER PAUL,** declare that this research report is my original work and has not been submitted to any other institution of higher learning for any academic award, publication, or other use.

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APPROVAL

This research report has been submitted under the guidance and approval of my supervisor.

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DEDICATION

I affectionately dedicate this work to my beloved parents and family, whose unconditional love, endless sacrifices and unwavering prayers have been the pillar of my academic journey.

To my lecturers, mentors and my fellow students, thanks you for guiding my hands, challenging my mind and above all instilling in me skills that meaningfully contribute to Uganda's agricultural sector.

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LIST OF ABBREVIATIONS AND ACRONYMS

AAW	Age at Weaning
AI	Artificial Insemination
ASF	African Swine Fever
FAO	Food and Agriculture Organisation of The United Nations
IFI	Inter Farrowing Interval
LI	Litter Index
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
NPWSY	Number of Piglets Weaned Per Sow Per Year
NPD	Non-Productive Days
PWM	Pre-Weaning Mortality
WSI	Weaning to Service Interval
UBOS	Uganda Bureau of Statistics
KCCA	Kampala Capital City Authority
COVAB	College of Veterinary Medicine, Animal Resources and Biosecurity
PDM	Parish Development Model

ABSTRACT

Reproductive efficiency and pre-weaning piglet survival are critical determinants of productivity and profitability in intensive pig production. However, limited data exist on these parameters among small-scale intensive farms in urban-peri-urban areas of Uganda. This study was set to; i. Characterise the litter size, age at weaning, weaning-to-service interval, Non- productive days, Inter- farrowing interval, litter index and the Piglets weaned per sow per year of sows managed under intensive production systems within selected parishes of Makindye Division, Kampala District. ii. Determine the prevalence and likely causes of pre-weaning piglet mortality in breeding herds within the study area. A cross-sectional study was conducted in selected parishes of Makindye Division, Kampala District. Ninety pig farmers were interviewed using a structured questionnaire, and reproductive data were collected from 151 breeding sow. Descriptive statistics (means, standard deviations, medians, and ranges) and frequency distributions were generated using STATA software. Chi-square tests were used to assess associations with pre-weaning mortality.

All farms used intensive, confined housing, with crossbred sows predominating (91.1%). Mean litter size was 9.46 ± 1.95 total born (9.09 ± 1.88 born alive), and 8.78 ± 4.66 piglets were weaned per litter, yielding 14.09 ± 3.56 piglets weaned per sow per year. Pre-weaning mortality was reported by 54.4% of farms (n=49). Among affected farms, 69.4% of mortalities occurred within 0–2 days of life. The leading causes were diarrhea (42.9%) and crushing by the sow (38.8%). Reproductive performance was moderate but significantly limited by high early neonatal mortality. Strengthening farrowing supervision, hygiene, creep feeding, and neonatal care can substantially reduce losses. Extension services should prioritize practical training on these aspects to enhance productivity in urban- and peri-urban pig farming systems in Uganda.

Keywords: Sow reproductive performance, pre-weaning piglet mortality, litter size, intensive pig production, Makindye Division, Kampala, Uganda.

CHAPTER ONE: INTRODUCTION

1.1 Background

Pig production constitutes a strategically important subsector of livestock agriculture globally, regionally and nationally. Pork is the most widely consumed meat in the world, accounting for approximately 36% of total global meat consumption more than poultry (33%) or beef (24%) and global pork production reached 124.5 million tonnes in 2023 (FAO, 2024). This sustained global demand reflects the pig's exceptional biological advantages, a short generation interval, high fecundity, efficient feed conversion, and the capacity to utilise a wide range of feed resources, including crop by-products and household waste, to produce high-quality animal protein (Ouma, Dione et al. 2013).

In sub-Saharan Africa, pig production has expanded rapidly, with continental output more than doubling from under one million tonnes in 2000 to over two million tonnes in 2021 (Adesehinwa et al., 2024). The pig population on the continent represents approximately 4.6% of the global herd and is predominantly managed by smallholder farmers using indigenous or crossbred genetics under extensive and semi-intensive systems (Adesehinwa et al., 2024). Uganda is among Africa's most significant pig-producing nations and the largest pork consumer per capita in East Africa, with estimated per-capita consumption of 3.4 kilograms per person per year (Babigumira et al., 2022). The national pig herd has grown dramatically, from 3.2 million animals in 2008 to 7.2 million in 2021 an increase of 122.5% and the number of pig-keeping households doubled from approximately 1.1 million to 2.2 million over the same period (UBOS, 2021). This growth reflects the pig's pivotal role in Uganda's agricultural economy and in household food security, income generation and poverty alleviation, particularly among women-headed smallholder households (Dione et al., 2014; Nabikyu & Kugonza, 2016).

Within Uganda, Kampala district, and its peri-urban environs in particular, record the highest pig densities in the country, driven by her proximity to one of East Africa's largest pork consumer markets (Roesel & Grace, 2014). The pork value chain in Kampala centres on a dense network of roadside pork joints and the Wambizzi abattoir , Kampala's only licensed pork slaughterhouse, the two together sustain the strong and growing demand for fresh pork (Katongole et al., 2012).

Makindye Division, one of the five administrative divisions of Kampala Capital City Authority, is among the most densely populated divisions in the capital and harbours a notable concentration of intensive piggery enterprises operating within its parishes. Unlike rural smallholder systems characterised by free-range management and very small herd sizes, the intensive farms of peri-urban Kampala maintain confined breeding herds, partial use of commercial feeds, and target market production through structured breeding programmes by some farms, characteristics that align them broadly with intensive production system definitions (Maes et al., 2020; Okello et al., 2015).

The reproductive performance of the breeding sow herd is the fundamental biological driver of a pig farm's profitability and sustainability. Every marketable pig ultimately originates from a reproductive breeding event, and the efficiency with which sows conceive, maintain pregnancy, farrow and wean viable litters determines the number of piglets entering the production pipeline. Key reproductive performance parameters; including litter size at birth, number of piglets born alive, litter index (litters per sow per year), weaning-to-service interval (WSI), inter-farrowing interval (IFI), non-productive days (NPD), sow parity, pre-weaning piglet mortality and the number of piglets weaned per sow per year (NPWSY) collectively determine the productivity of the breeding herd and must be measured, monitored and benchmarked if targeted improvement is to be achieved (Knol et al., 2022; Koketsu et al., 2021; Sanz-Fernández et al., 2024).

International benchmarks for high-performing intensive herds target more than 17.2 total piglets born per litter, a farrowing rate of 85–90%, a litter index of 2.2–2.4 litters per sow per year, a WSI of fewer than 7 days, fewer than 10 non-productive days per reproductive cycle, and the NPWSY exceeding 30 piglets (Knox, 2016; Koketsu et al., 2021). Available field data from Kampala district and its peri-urban environs indicate that reproductive performance on intensive farms departs substantially from these benchmarks; (Okello et al., 2015) reported a litter index of only 1.8, a WSI of 49.9 days, an IFI of 217.5 days, a mean of 8.19 piglets weaned per litter and a pre-weaning mortality of 16.3%. These data, however, were generated from farms in Wakiso, Nansana, Nangabo and Kira, peri-urban town councils immediately adjacent to Kampala. There is no such an equivalent systematic evaluation that has been published specifically for Makindye Division. The reproductive performance status of breeding sow herds within Makindye parishes therefore remains undocumented, and the specific management and health factors contributing to any performance gaps in this location remain uncharacterised.

1.2 Problem Statement

Despite the rapid growth of pig production in Kampala district and the documented importance of intensive piggery enterprises to urban livelihoods and food security, the reproductive performance of breeding sow herds within Makindye Division has not been systematically evaluated. The available evidence from peri-urban Kampala indicates that key reproductive parameters including litter index (LI), WSI, IFI, NPWSY and pre-weaning piglet mortality (PWM) fall substantially below international benchmarks of (10-20)% (Babigumira et al., 2023; Okello et al., 2015), yet the specific reproductive performance profile and the relative contribution of individual parameters to the overall herd inefficiency remain unquantified for piggery farms based in Makindye division. In the absence of farm-level reproductive data, veterinary extension services, farm managers and policy makers lack the evidence base needed to identify which parameters most urgently require intervention and to design appropriately targeted productivity-improvement programmes.

Concurrently, pre-weaning piglet mortality reported at 16.3% (Okello et al., 2015) in peri-urban Kampala farms and as high as 31% in intensively managed Nigerian herds (Abah et al., 2019) represents a major direct economic loss and an indicator of failures in farrowing management, neonatal care, sow nutrition and herd health. The prevalence of pre-weaning mortality in Makindye Division breeding herds has not been established, and the principal causes of piglet death i.e. whether due to overlying, starvation/hypothermia, infectious disease, or congenital abnormalities, all have not been systematically investigated in this context. Without this information, interventions to reduce piglet losses remain generic rather than targeted to the specific aetiological profile of the study area.

The knowledge gap is further compounded by deficiencies in herd record keeping. Structured records on parity, mating dates, farrowing dates, litter size and piglet mortality are frequently incomplete or absent on Kampala-area intensive farms (Okello et al., 2015), making retrospective analysis impossible and rendering real-time performance monitoring ineffective. This study therefore addresses a concrete and consequential evidence gap: the lack of baseline reproductive performance data for breeding sow herds in Makindye Division, Kampala District, and the absence of systematic information on the incidence and aetiology of pre-weaning piglet mortality in this production environment.

1.3 Study Objectives

1.3.1 General Objective

To evaluate the reproductive performance of breeding sows and associated management factors within selected parishes of Makindye Division, Kampala District.

1.3.2 Specific Objective

i. To characterise the litter size, age at weaning, weaning-to-service interval, Non- productive days, Inter- farrowing interval, litter index and the Piglets weaned per sow per year of sows managed under intensive production systems within selected parishes of Makindye Division, Kampala District.

ii. To determine the prevalence and likely causes of pre-weaning piglet mortality in breeding herds within the study area.

1.4 Research Questions

1. What are the characteristics and levels of litter size, age at weaning, weaning-to-service interval, Non- productive days, Inter- farrowing interval, litter index and the Piglets weaned per sow per year of sows managed under intensive production systems within selected parishes of Makindye Division, Kampala District?
2. What is the prevalence and likely causes of pre-weaning piglet mortality in breeding herds within the study area?

1.5 Justification of the study

Pig production is a primary livelihood strategy for a substantial proportion of households in Makindye Division and the broader Kampala metropolitan area, and pork constitutes an important and affordable animal-protein source for urban consumers. Sub-optimal sow reproductive performance expressed through reduced litter sizes, elevated pre-weaning mortality, extended inter-farrowing intervals and inflated non-productive days directly reduces the number of piglets weaned per sow per year, thereby undermining farm profitability, household income and urban pork supply. Profitability analyses in peri-urban Wakiso demonstrated that record keeping and access to extension services were among the strongest determinants of gross profit per pig, confirming that evidence-based management improvements generate measurable economic returns (Nabikyu & Kugonza, 2016). Equally, improving reproductive efficiency increases pork output without requiring proportional increases in herd size, land use or feed input a critical consideration in a land-constrained urban areas (Roesel & Grace, 2014).

The most directly relevant published study of peri-urban Kampala intensive pig production (Okello et al., 2015) was conducted in the town councils surrounding the capital not within Makindye Division itself and the data is now a decade old. Significant changes in herd genetics, ASF disease pressure, feed markets and management practices have occurred in the intervening period, and no equivalent systematic survey covering Makindye Division parishes has been published.

This study will generate the first systematic baseline reproductive performance dataset for Makindye Division, directly informing the design of extension messages and recommendations appropriate for the specific constraints of this urban production environment.

1.6 Significance of the study

This study will generate a primary dataset on the reproductive performance of intensive breeding sow herds within Makindye Division, data that currently does not exist in the published literature. The systematic characterisation of the selected reproductive performance parameters across the representative sample of study farms will establish a statistically robust local baseline against which future performance can be benchmarked and the impact of planned interventions evaluated. The pre-weaning mortality aetiology data will make a direct contribution to the limited body of published evidence on cause-specific piglet mortality in urban African intensive pig systems, which currently relies predominantly on studies from rural smallholder contexts in Uganda and Kenya (Dione et al., 2022; Ikwap et al., 2014) and will close an important evidence gap for this specific production environment.

At the applied and policy levels, the identification of parameters most severely deviating from benchmarks will enable veterinary practitioners, animal husbandry extension officers and farm managers to prioritise interventions for example; nutritional (poor BCS and elevated WSI), reproductive (NPD and IFI compression), management-based (weaning age standardisation and farrowing supervision) or health-based (vaccination and biosecurity) in a manner grounded in local context-specific evidence rather than extrapolation from geographically or temporally distant datasets.

CHAPTER TWO: LITERATURE REVIEW

2.1 Overview of Pig Production

2.1.1 Global and African Pig Production Trends

Pork is the most widely consumed meat globally, accounting for approximately 36% of total meat consumption, ahead of poultry 33% and beef 24% (Adesehinwa et al., 2024). Global pork production reached 124.5 million tonnes in 2023 a 1.4% increase from the preceding year with china alone contributing 58.8 million tonnes, equivalent to approximately 47% of the world's output (FAO, 2024). Projections from the Organisation for Economic Cooperation and Development and the Food and Agriculture Organisation indicate that world pork output will rise to approximately 131.1 million tonnes by 2033, driven by the rising urban incomes and the shifting dietary preferences across Asia and the Sub-Saharan Africa (FAO, 2024). These global trends underline the strategic importance of pig production as a pillar of food security and source of agricultural income.

Africa's contribution to global pork production stands at approximately 1.67%, yet the continental output has more than doubled from under one million tonnes in 2000 to over two million tonnes in 2021, reflecting a rapidly expanding sector (Adesehinwa et al., 2024), with African Swine Fever as the most significant constraint to the sustainable continental growth (Penrith et al., 2019).

2.1.2 Pig Production in Uganda

Uganda ranks among the top five pork producing countries in Africa and records the highest per capita pork consumption in East Africa, estimated at 3.4 kg per person per year (Babigumira et al., 2022). (UBOS, 2021) reported that the national pig population stood at 7.2 million in 2021, a 122.5% increase from 3.2 million pigs in 2008, while the number of pig keeping households doubled from approximately 1.1 million to 2.2 million over the same period. Pigs are valued for their short reproductive cycle, high prolificacy and capacity to convert household and crop residues into animal protein, thereby supporting food security and rural livelihood (Ouma et al., 2013). Women headed households constitute a disproportionately large segment of pig keeper, underscoring the species' role in poverty alleviation and gender inclusive development (Dione et al., 2014; Nabikyu & Kugonza, 2016).

Despite the sector's growth trajectory, the Ugandan piggery industry remains predominantly characterised by smallholder farmers, low input systems, with over 80% of the herds maintaining between 1 – 5 animals (Babigumira et al., 2022). Shared village boars are commonly used for mating and access to veterinary services, improved genetics and formulated commercial feeds remains limited (Dione et al., 2014). AFS is endemic and constitutes the most significant production constraint, periodically causing whole herd losses that disrupt market chains (Aliro et al., 2022). Published research indicates that African Swine Fever causes severe economic damage in Uganda, with affected smallholder households losing nearly half their pig population which results into significant cash flow crisis (Chenais, E., et al. 2017). Studies also confirm high incidence rates, widespread environmental contamination on farms, and that panic- selling of sick animals acts as a primary vector for transmission (Dione, M., et al. 2017).

2.1.3 Urban and Peri-Urban Pig Farming in Kampala and Makindye Division

The highest pig density in Uganda is recorded in peri-urban Kampala, reflecting its proximity to a high-density pork consumer market centred on roadside pork joints and the Wambizzi abattoir, Kampala's only licensed pork slaughterhouse (Roesel & Grace, 2014). A structured survey of livestock rearing households across Kampala's four divisions including Makindye identified pigs as the third most commonly reared species (34.2% households), after dairy cattle and chicken, with feed scarcity, disease and high veterinary service costs cited as the leading constraints (Katongole et al., 2012). Makindye Division accommodates a notable concentration of intensive piggery enterprises within its parishes, making it a relevant context for evaluating intensive system breeding sows' reproductive performance.

2.2 Reproductive Performance Parameters

Reproductive performance parameters collectively determines the number of marketable piglets produced per sow per unit time. Each parameter reflects a distinct physiological process or management outcome and deficiencies in any one of them compounds losses across the entire production cycle. The following sub sections examine each key reproductive performance parameter independently, with reference to international benchmarks and field data reported from Uganda and the broader East African region.

2.2.1 Sow Parity

Parity is defined as the number of times a sow has farrowed, and constitutes both an individual descriptor of reproductive maturity and a herd-level structural variable that strongly conditions reproductive output across all other performance parameters. Performance follows a characteristic non-linear trajectory i.e. gilts and first-parity (primiparous) sows produce the smallest litters with the longest weaning-to-service intervals and the lowest farrowing rates, performance rises to the peak between the 3 and 5 parities, then plateaus or declines in older sows (Klimas et al., 2020; Koketsu et al., 2021). In a large tropical dataset of 258 Landrace sows in Northern Thailand encompassing 2,322 records across parities 1 to 9, (Thiengpimol et al., 2024) quantified this trajectory precisely i.e. the number of piglets born alive rose from 9.29 at parity 1 to a peak of 11.38 at parity 4, then declined to 9.67 by parity 9, while piglet losses at birth were lowest at parity 2 (0.86) and peaked at parity 8 (2.05). The authors identified parities 2 to 6 as the most productive period in the reproductive lifespan of sows and described the parity curve best with a third-degree polynomial. Parity also significantly affects farrowing duration: sows of parities 5 to 10 had significantly longer farrowing durations (237–248 minutes) than parity 1 sows (188 minutes) under tropical free-farrowing conditions, elevating intrapartum asphyxia and stillbirth risk (Thiengpimol et al., 2024).

At the herd level, an optimal parity structure is critical to maximising reproductive efficiency. Industry guidance recommends a herd-average parity of 2.5 to 3.5, with over 45% of sows in parities 3 to 6 and no more than 15–20% of the herd comprising gilts and first-parity sows (Koketsu et al., 2021).

2.2.2 Sow Parity Distribution and Herd Structure

Sow parity distribution is the proportion of sows in each parity class within the breeding herd and it's a critical determinant of the overall herd reproductive efficiency. An optimal parity distribution concentrates sows in the peak performance parities (3-5) and maintains a steady replacement rate to prevent the accumulation of old sows (6 parities and above), whose reproductive performance and longevity decline. A commonly recommended target distribution allocates approximately 15-20% of the herd to gilts and first parity sows, 60-65% to parities 2-5, and not more than 15-20% to parity 6 and above (Koketsu et al., 2021). Deviation from this distribution through excessive culling of young sows, inadequate gilt supply or failure to remove aged sows' biases herd average performance either towards lower producing young sows or declining older animals.

In Ugandan smallholder and peri-urban intensive systems, structured gilt development and replacement planning are rarely practised. (Babigumira et al., 2022) noted that breeding decisions in smallholder herds are largely opportunistic, with gilts mated at their first or second observed oestrus irrespective of body weight or age targets, and with culling governed by financial necessity rather than performance data. (Okello et al., 2015) observed indiscriminate crossing across parities and breeds in intensive per-urban Kampala farms. With limited systematic recording of parity to guide culling or replacement decisions. The resulting skewed parity distributions contribute to herd average reproductive performance that falls below the level achievable even with the existing genetic material, if appropriately managed.

2.2.3 Gestation Length

The gestation length of domestic pigs' averages at 115 days (ranges 112-120) days, and is relatively consistent across various breeds and management systems, making it one of the most stable reproductive parameters (Knox, 2016). Despite its narrow biological variability, gestation length has practical significance for herd scheduling for example; accurate predication of farrowing date based on service date underpins the allocation of farrowing accommodation, timing of sow transfer to farrowing crates and the scheduling of pre- farrowing vaccinations and colostrum supplementation preparations (Soede et al., 2011). Deviations from expected gestation length particularly premature farrowing before day 112 results into the birth of immature piglets with low viability, inadequate colostrum absorption capacity and markedly elevated pre-weaning mortality risks (Farmer & Edwards, 2022). In Ugandan production contexts, where record keeping is often incomplete, inaccurate recording of service dates generates uncertainty in the expected farrowing dates, undermining preparatory management and contributing to unattended or poorly supervised farrowing (Okello et al., 2015).

2.2.4 Litter Size at Birth

Litter size at birth encompassing total piglets born (total born alive plus the stillbirths) and the piglets born alive is the most fundamental indicator of sow prolificacy and is determined primarily by ovulation rate and the embryonic survival (Rempel et al., 2022). Under optimal management, sows of modern dam-line breeds can ovulate approximately 20 oocytes per cycle, though total litter size is ultimately constrained by uterine capacity and the efficiency of embryo implantation

(Knox, 2016). Industry benchmarks propose targets of more than 22.3 total born piglets per litter (Sanz-Fernández et al., 2024).

In practice, field data from peri-urban Kampala reveals substantial shortfalls. (Okello et al., 2015) reported a mean total litter size of 10.5 ± 3.9 and piglets born alive 9.84 ± 3.39 across 90 intensive farms, while (Babigumira et al., 2023) recorded only 7.2 ± 2.3 born alive piglets across smallholder farms in Hoima and Kamuli districts. Parity exerts a well-established influence on litter size, with total born increasing progressively from parity one , peaking at 3-5th parities and declining thereafter (Corrales-Hernández et al., 2025).

Breed is equally important: mean litter sizes in peri-urban Kampala ranged from 11.7 for Camborough to 8.1 for indigenous breeds (Okello et al., 2015), reflecting the prolificacy advantage of improved dam-line genetics. Genomic analyses further demonstrated that sows with a higher proportion of modern European ancestry weaned 2.4 more piglets than those with lower exotic ancestry (Babigumira et al., 2023), confirming the role of genetic composition in determining litter size in Ugandan herds.

2.2.5 Stillbirths and Mummified Foetuses

Stillbirths are defined as piglets that complete full gestational development but are born dead, and are conventionally distinguished from mummified foetuses which result from intrauterine fetal death during mid to late gestation (Muns et al., 2016). Stillbirths represent a direct reduction in the number of piglets available for rearing and are a sensitive indicator of farrowing management quality, since a significant proportion arise from intrapartum asphyxia during prolonged farrowing or difficult birth intervals. The internationally accepted benchmark for stillbirths is fewer than 0.2 per litter or less than 5% of the total born piglets (Renken et al., 2021). Elevated stillbirth rates are associated with large litter sizes, prolonged farrowing duration, high ambient temperature, advanced parity and absence of farrowing supervision (Corrales-Hernández et al., 2025).

(Okello et al., 2015) reported a mean of 0.7 ± 1.2 stillbirths per litter across intensive peri-urban Kampala farms a figure above the international benchmark. A proportion of these losses were attributed to unsupervised and prolonged farrowing in the absence of stockperson intervention. Seasonal thermal stress compounds this risk, (Akkhaphan et al, 2025) demonstrated that an elevated temperature- humidity index in the 7 days preceding farrowing significantly extended farrowing and the inter- birth intervals, directly increasing the probability of intrapartum asphyxia.

Mummified fetuses that typically occur when a foetus dies after day 35 of gestation, following development of the immune system may signal subclinical parvovirus infection or other reproductive pathogens in within the breeding herd, underscoring the diagnostic value of systematic recording of mummification rates (Lambert et al., 2012).

2.2.6 Average Age at Weaning.

Average age at weaning is the age at which the piglets are separated from the sow, it's a management decision with significant consequences for the sow's reproductive efficiency, piglet's health and their post weaning performance. In commercial intensive systems, weaning at 21 to 28 days of age is a standard practice, as it minimises lactational body reserve mobilisation by the sow, shortens the WSI and IFI, and enables sows to initiate a new reproductive cycle with adequate body condition (Soede et al., 2011). Earlier weaning (before 21 days) is associated with increased incidence of post-weaning oestrus failure, particularly in the primiparous sows, while extended lactation (beyond 35 days) substantially prolongs the IFI without proportional gains in piglet survival or weaning weight (Knox, 2016).

In peri-urban Kampala, (Okello et al., 2015) documented a mean weaning age of 54.5 ± 9.1 days, nearly double the recommended maximum of 28 days. This extended lactation pattern, which likely reflects both cultural husbandry norms and insufficient awareness of the relationship between weaning age and sow reproductive tempo, is a primary driver of the elevated WSI (49.9 days) and inflated IFI (217.5 days) documented in the same farms. Adoption of a standardised 21 to 28 days weaning protocol, coupled with appropriate creep feeding and post-weaning piglet management would be expected to substantially compress the IFI and increase litters per sow per year, thereby raising the number of piglets weaned per sow per year even in the absence of change to litter size or pre- weaning mortality.

2.2.7 Number of Piglets Weaned Per Litter (NPWL)

The number of piglets weaned per litter is determined by the interaction of litter size at birth and the pre- weaning piglet mortality and represents the most directly and commercially relevant litter parameter, as it equates to the number of animals entering the post – weaning production system. Elite herds in Spain where intensive genetics and management are highly advanced achieve a mean number of piglets weaned per litter exceeding 17.2 piglets (Sanz-Fernández et al., 2024).

Field performance across East Africa falls substantially below these targets. (Okello et al., 2015) recorded a mean of 8.19 ± 2.77 piglets weaned per litter in intensive per-urban Kampala farms, while (Babigumira et al., 2022) reported 6.1 ± 2.2 weaned piglets per litter in smallholder herds in Hoima and Kamuli. Comparable data from (Abah et al., 2019) in Nigerian intensive herds yielded only 5.3 ± 0.73 weaned piglets per litter. The relatively modest weaned litter sizes recorded in Ugandan intensive farms results from a combination of moderate born alive piglet numbers and the significant pre-weaning mortalities. Breed effects are also important, sows with greater proportions of exotic European ancestry consistently wean more piglets per litter than local or low-grade crossbred sows (Babigumira et al., 2023; Okello et al., 2015).

2.2.8 Inter- Farrowing Interval (IFI)

The inter-farrowing interval (IFI), or the farrowing to farrowing interval represents the total number of days between two consecutive farrowings by the same sow and is a composite measure integrating gestation length (approximately 115 days), lactation length and the weaning to service interval (WSI). Under a standard 21-days lactation and a 5-7 days WSI, the expected IFI is approximately 141 days, yielding a theoretical litter index of approximately 2.58 (Knox, 2016) . Any prolongation of lactation or the WSI directly inflates the IFI and reduces annual litter output. The international benchmark for IFI is (144-155) days, corresponding to 2.35-2.53 litters per sow per year (Sanz-Fernández et al., 2024).

(Okello et al., 2015) recorded a mean IFI of 217 ± 30.6 days across intensive farms , nearly 73 days beyond the benchmark upper limit thereby yielding a farrowing index of only 1.8 litters per sow per year compared to the target of 2.35 or above. This single parameter deficiency alone reduces annual piglet output per sow by approximately 30% with compounding downstream effects on farm profitability. The primary drivers of this extended IFI in Kampala farms are the prolonged lactation periods and the markedly elevated WSI and the occasional return to heat after service, all of which are amenable to management correction. Comparable findings have been reported from other African intensive systems, for example; Nigerian intensive herds, documented a NPWPY of only 8.1, partly attributable to extended inter-farrowing intervals resulting from nutritional and management deficiencies (Abah et al., 2019).

2.2.9 Number of Piglets Weaned Per Sow Per Year (NPWSY)

Piglets weaned per sow per year, also referred to as the sow productivity index is the single most widely used composite measure of breeding herd efficiency, integrating litter size, pre-weaning survival and the reproductive tempo (litters per sow per year) into one productivity metric (Knol et al., 2022; Koketsu et al., 2021). NPWSY is calculated as the product of litters per sow per year and the piglets weaned per litter, and therefore captures the cumulative effect of all intermediate reproductive parameter. Under commercial intensive conditions, NPWSY targets in high performing European herds exceeds 28 to 30 piglets per sow per year (Knox, 2016), with Spanish farms averaging at 40 piglets per sow per year (Sanz-Fernández et al., 2024).

In African intensive systems, NPWSY is dramatically lower. (Abah et al., 2019) reported a NPWSY of only 8.1 ± 1.21 in Nigerian smallholder intensive herds. While specific NPWSY data for Kampala were not directly reported by (Okello et al., 2015), the documented farrowing index of 1.8 and weaned litter size of 8.19 yield an estimated NPWSY of approximately 14.7 representing less than half the European benchmark. The NPWSY deficit in Ugandan smallholder intensive systems reflects simultaneous underperformance across multiple component parameters like; prolonged WSI, extended IFI, moderate born alive numbers and significant pre-weaning mortality thus underscoring the multiplicative nature of reproductive performance losses. Improving NPWSY requires an integrated approach targeting all contributing parameters rather than isolated single parameter interventions.

2.2.10 Litter Index (LI)

The litter index also termed farrowing index or litters per sow per year (LSY) is the average number of litters a sow produces in a 12-month period, calculated as 365 divided by the mean inter-farrowing interval (Koketsu et al., 2021). It is one of the two principal multiplicative drivers of overall sow productivity; NPWSY equals litters per sow per year multiplied by piglets weaned per litter, so any reduction in the litter index directly and proportionally lowers annual piglet output (Koketsu et al., 2021). Given a gestation of approximately 115 days, a 21- to 28-day lactation and a target weaning-to-service interval of fewer than seven days, the biological ceiling for the litter index is approximately 2.5 to 2.57 litters per year (Knox, 2016). International benchmarks target 2.2 to 2.4 litters per sow per year, with top-performing Spanish commercial herds achieving 2.39 to 2.50 in recent years (Sanz-Fernández et al., 2024).

In peri-urban Kampala, (Okello et al., 2015) recorded a litter index of only 1.8 across 90 intensive farm approximately 0.4 to 0.7 litters below the international target, driven primarily by an excessively long weaning-to-service interval (49.9 days) and a mean inter-farrowing interval of 217.5 days. This shortfall translates into an estimated loss of 3 to 6 piglets weaned per sow per year compared with a system achieving the 2.2 benchmark. These consistently sub-optimal litter indices confirm that compressing the weaning-to-service interval and reducing non-productive days represent the highest-leverage interventions for raising NPWSY in peri-urban East African pig production systems.

2.2.11 Non-Productive Days (NPD)

Non-productive days (NPD) are defined as any day on which a sow or eligible breeding gilt is present in the herd but is neither pregnant nor lactating, and therefore generates maintenance costs without contributing to productive output. The main sources of NPD include the weaning-to-first-service interval (the largest single component, accounting for approximately 50% of total NPD), intervals arising from repeat matings and returns to oestrus, days lost following abortion before re-mating, delays between identifying an open sow and culling, and gilt days from herd entry to first service (Koketsu et al., 2020). Each additional non-productive day directly reduces the achievable litter index and NPWSY, an annual NPD of approximately 35 days supports a potential litter index of 2.44, while NPD of 85 days lowers the ceiling to only 2.07 litters per sow per year. International benchmarks target fewer than 10 non-productive days per reproductive cycle, with top-decile commercial herds averaging approximately 36 NPD annually compared with 72 NPD in bottom-decile herds (Sanz-Fernández et al., 2024).

In tropical and African production systems, NPD is consistently elevated above the international benchmark by a combination of poor sow nutrition during lactation, heat-stress-induced suppression of post-weaning oestrus, inadequate boar exposure and heat detection, disease-related abortions, and weak culling discipline (Okello et al., 2015). In peri-urban Kampala, the weaning-to-service interval alone averaged approximately 50 days (Okello et al., 2015), and in intensive Nigerian herds in Abuja, a weaning-to-service interval of 39.4 ± 4.6 days contributed to a NPWSY of only 8.1 ± 1.21 (Abah et al., 2019) both indicating annual NPD far in excess of benchmarks. Practical strategies to reduce NPD include structured post-weaning boar exposure, optimisation of lactation nutrition to improve sow body condition at weaning, early pregnancy diagnosis, prompt culling of open sows, and vaccination against reproductive pathogens to minimise abortion-related losses (Koketsu et al., 2021).

2.3 Pre-Weaning Piglet Mortality

2.3.1 Definition, Significance and Global Incidence

Pre-weaning mortality PWM is defined as the proportion of piglets born alive that die between birth and weaning. It represents one of the most economically significant production losses in pig farming, directly reducing the number of marketable piglets produced per sow per year (Edwards & Baxter, 2015; Muns et al., 2016). Globally, PWM ranges from 10-20%, with the majority of deaths occurring within the first 48 to 72 hours postpartum (Muns et al., 2016). A 10-year analysis of large commercial herds found that herd mean PWM increased from 11.9% to 14.4% as average litter sizes increased (Koketsu et al., 2021), highlighting the trade-offs between genetic selection for prolificacy and piglet's survival. Reported rates as high as 31% have been documented in Nigerian intensive systems (Abah et al., 2019), illustrating the severity of losses under tropical production conditions.

2.3.2 Aetiology and Causes

Overlying (crushing by the sow) is consistently identified as the single leading direct cause of pre-weaning death, accounting for approximately 50% of all pre-weaning piglet deaths, with the majority occurring within the first week postpartum (Spörri-Vontobel et al., 2023). Starvation and hypothermia collectively account for 16 - 17% of deaths and are most severe in low-birth-weight piglets that fail to ingest adequate colostrum within 24 hours. (Spörri-Vontobel et al., 2023) demonstrated that 71% of piglets weighing 1.11 kg or less consumed fewer than 300 grams of colostrum in their first day of life. Infectious diseases like neonatal colibacillosis, Streptococcus suis septicaemia, clostridial enteritis, coccidiosis, transmissible gastroenteritis and ASF contribute a further 10 - 15% of losses (Chenais et al., 2017) Congenital defects and intrapartum asphyxia from prolonged farrowing are additional contributors.

2.3.3 Incidence in Uganda and East Africa

In Uganda and the broader East African region, PWM rates substantially exceed those of optimally managed commercial herds. (Okello et al., 2015) recorded an average of 1.7 ± 1.5 piglet deaths per litter (approximately 16.3% mortality) across 90 intensive peri-urban Kampala farms. (Dione et al., 2022) reported overall piglet mortality of 10.2% (95% CI: 8.5 - 12.9%) across 270 farms in Masaka, Mukono, Mpigi and Wakiso Districts. (Wabacha et al., 2004) recorded a crude PWM of 18.7% across smallholder herds in Kikuyu Division, Kenya, with 78.8% of deaths in the first week and 69% attributed to overlying. (Ikwap et al., 2014) observed that 38% and 23% of herds in Gulu and Soroti Districts reported diarrhea and respiratory disease in piglets, respectively, indicating widespread infectious disease burden contributing to mortality.

2.3.4 Strategies for Reducing Pre-Weaning Piglet Mortality

Interventions with demonstrated efficacy include split-suckling of large litters to ensure colostrum access by lighter piglets, cross-fostering within 12–24 hours, heated creep areas maintained at 32–34°C, routine iron supplementation within three days of birth, farrowing supervision and pharmacological induction in prolonged gestations, pre-farrowing sow vaccination against E. coli and clostridial pathogens, and genetic selection for maternal behavioural traits (Muns et al., 2016), (Edwards & Baxter, 2015).

CHAPTER THREE: METHODOLOGY

3.1 Study Design

This study employed a cross-sectional survey design with a repeated- farm visit component. Primary respondents were identified using parish development model(PDM) lists of piggery beneficiaries obtained from the parish chiefs of Luwafu, Salaama, and Ggaba parishes prior to commencement of data collection, these lists represent the most locally authoritative and up-to-date records of registered pig-keeping households within each parish. Secondary respondents were recruited through referral by the primary respondents, using a snowball approach to capture active breeding sow farmers not appearing on the official PDM lists. For farms where complete data couldn't be obtained at the first visit for example, where the sow was still lactating and pre-weaning mortality and its probable etiology couldn't be fully determined, a scheduled follow-up visit was conducted after weaning to collect the outstanding information. This repeated-visit component ensured that all reproductive performance parameters and complete pre-weaning mortality data was captured for every enrolled sow, preventing information gaps that would compromise the integrity of the dataset.

3.2 Study Area

The study was conducted within selected parishes of Luwafu, Salaama, and Ggaba of Makindye Division, Kampala District, Uganda. Makindye Division lies in the south Eastern corner of Kampala at approximately 0°17'N, 32°35'E, an altitude of 1,100–1,200 metres above sea level, with a tropical rainforest climate, mean annual temperatures of 21–23°C, and bimodal annual rainfall of approximately 1,260–1,500 mm. The division's peri-urban character is defined by a mixture of residential, commercial, and smallholder agricultural land uses which support a significant density of intensive pig confinement enterprises that supply Kampala's urban pork market. Luwafu is a mid-elevation peri-urban parish with documented intensive livestock enterprises. Salaama encompasses a socio-economically diverse range of communities from the Buziga hilltop to low-income zones, capturing varied management and feeding practices, and Ggaba, located on the shore of Lake Victoria, offers farmers access to abundant low-cost fish waste and market by-products as supplementary pig feeds. These three parishes host a sufficient density of breeding sow enterprises that supported the study's enrolment targets.

3.3 Study Population

The study population comprised of all pig farmers actively maintaining at least one breeding sow under intensive or semi-intensive confinement management in the selected parishes of Luwafu, Salaama, and Ggaba of Makindye Division, Kampala District. The primary study units were individual breeding sows that had completed at least one farrowing event in the past 12 months preceding data collection, from which reproductive performance parameters and pre-weaning mortality data was directly captured. Farmers operating fully extensive free-range systems or maintaining only growing and finishing pigs without an active breeding sow were excluded from the study population.

3.4 Sample Size Determination

The sample size for this study was be calculated using the Cochran formula for proportions:

$$n = \frac{Z^2 P(1-P)}{d^2}$$

Where n is the minimum sample size, Z is the standard normal deviate corresponding to the desired confidence level (1.95 for 95%) p = 0.16 estimated prevalence of reproductive performance problems and d is the desired margin of error (0.05). This yields:

$$n = \frac{(1.96)^2(0.16)(1-0.16)}{(0.05)^2} = 276$$

Thus, at least 276 reproduction records were to be reviewed. To account for incomplete or missing data, a 15% for non-response and incomplete records was included, bringing the total sample size to a minimum of 317 sow-level records. Additionally, approximately 90–120 pig farms were purposively included and distributed proportionally across the three parishes.

3.5 Sampling Technique

A three multistage technique was employed as follows;

3.5.1 Stage 1: Purposive Selection of the Study Parishes

The three study parishes Luwafu, Salaama, and Ggaba were purposively selected from Makindye Division's 21 parishes based on documented concentration of intensive pig enterprises, representation of the principal ecological and socio-economic pig production contexts of the division, and accessibility via paved or all-weather roads.

3.5.2 Stage 2: Systematic Random Selection of Primary Respondents

Parish development model lists of piggery beneficiaries were obtained from the parish chiefs of the selected parishes prior to data collection. These lists served as the sampling frame for primary respondents.

3.5.3 Stage 3: Snowball Referral of Secondary Respondents

To capture active breeding sow farmers not appearing on official PDM lists, each enrolled primary respondent was asked to refer up to two other pig farmers within the same parish known to be actively maintaining a breeding sow. Referred farmers meeting the inclusion criteria were enrolled as secondary respondents. Snowball referral was continued until the total enrolment target was reached or referral chains within the parish were exhausted.

3.5.4 Repeated Farm- Visit

Where a sow was still lactating at the time of the first farm visit and pre-weaning mortality data couldn't be fully quantified, the farm was retained in the dataset and a scheduled follow-up visit was arranged after weaning. This component applied to both primary and secondary respondents and ensured completeness of sow-level data across all enrolled farms.

3.6 Inclusion and Exclusion Criteria

3.6.1 Inclusion

1. Farms maintaining at least one breeding sow with a minimum of one farrowing event in the preceding 12 months.
2. Respondents who agreed to a written or verbal informed consent to participate.
3. Farms that operate under intensive confinement management.

3.6.2 Exclusion

1. Farms with insufficient records and where the farmer cannot recall key dates for at least one complete reproductive cycle per sow.
2. Farms devastated by a disease outbreak (e.g., ASF) within the preceding 12 months, substantially altering normal herd function.

3.7 Data Collection Method

A structured Farmer Interview Questionnaire was administered to the primary person responsible for pig management at each enrolled farm, capturing farm demographics, herd structure, farmer breed and trait preferences, follow-up reproductive performance data using a Sow-Level Reproductive Performance Recording Table, a standardised data sheet populated from farm records or farmer recall for each breeding sow, capturing the given sow ID, parity, breeding method, total born, born alive, stillbirths, PWM%, age at weaning, WSI, NPD, IFI, the computed litter index, NPWSY and the pre-weaning mortality incidence, its observed causes, and associated management practices. Farm Records Review E.g. Farrowing cards, service records, weaning dates, mortality logs, and veterinary treatment records were reviewed and data abstracted using a standardised extraction form. Also, direct Farm Observation Checklist were completed by the enumerator at each visit to document farrowing unit design, heat provision, hygiene, and management practices relevant to all the two specific objectives.

3.8 Key Variables and Their Operational Definitions

Table 1: Key variables and their operational definitions

Parameter	**Unit**	**Operational Definition**
Inter-Farrowing Interval (IFI)	Days	Days between two consecutive farrowings for the same sow
Non-Productive Days (NPD)	Days/sow/year	Days the sow is neither pregnant nor lactating, per year
Weaning-to-Service Interval (WSI)	Days	Days from litter weaning to first post-weaning mating or AI
Litter Index (LI)	Litters/sow/year	12 ÷ IFI (months)
Age at Weaning (AAW)	Days	Age of piglets at weaning from the sow
Pre-Weaning Mortality (PWM)	Percentage (%)	(Weaned Piglets-Pre-weaning Deaths÷ live-born) × 100, per litter
Piglets Weaned per Litter	Number	Live piglets surviving to weaning per litter
NPWSY	Number	Average weaned per litter × Litter Index

3.9 Data Management and Analysis Plan

Data was entered into Microsoft Excel and analysed using STATA statistical software (version 18.0). Descriptive statistics (frequencies, percentages, means, standard deviations, medians, interquartile ranges, and ranges) were computed for sociodemographic characteristics, farm management practices, and reproductive performance parameters. For pre-weaning mortality etiology, proportionate frequencies among farms reporting mortality were calculated. Chi-square tests were used to assess associations between variables (e.g., age at mortality, causes, and floor type) and the occurrence of pre-weaning mortality. Statistical significance was set at $p < 0.05$. Findings were presented in appropriate tables with percentages rounded to one decimal place.

3.10 Ethical Considerations

Approval was sought from the **Makerere University College of Veterinary Medicine, Animal Resources and Biosecurity (COVAB)**. Permission to access farm data was obtained from the relevant Division's Animal Husbandry authorities. Participation was voluntary, and written/ verbal informed consent was obtained from all farmers prior to data collection. Confidentiality was maintained by excluding identifiable information from datasets. The study posed minimal risk to participants as it involved retrospective data review and interviews without any invasive procedures. Findings will be shared with participants and relevant stakeholders to contribute to improving reproductive management in Uganda's pig industry.

CHAPTER FOUR: RESULTS

4.1 Sociodemographic Characteristics of Study Participants

A total of 90 pig farmers/respondents were interviewed in selected parishes of Makindye Division, Kampala District. The majority of respondents originated from Salaama parish (n = 36, 40.0%), followed by Luwafu (n = 28, 31.1%) and Ggaba (n = 24, 26.7%). Most participants were farm owners (n = 61, 67.8%). There was a slight male predominance (n = 50, 55.6%). The respondents were largely in the middle age groups, with 25–40 years (n = 39, 43.3%) and 41–55 years (n = 39, 43.3%). Regarding education, secondary level was the most common (n = 32, 35.6%), followed by diploma (n = 18, 20.0%) and bachelor's degree (n = 16, 17.8%). In terms of experience, most farmers had 2–5 years (n = 37, 41.1%) or 6–10 years (n = 36, 40.0%) in pig farming.

Table 2: Socio-Demographic characteristics of the study participants (N=90)

Characteristic	Category	Frequency (n)	Percentage (%)
Parish	Ggaba	24	26.7
	Luwafu	28	31.1
	Salaama	36	40.0
Respondent	Both	24	26.7
	Care taker	5	5.6
	Farm owner	61	67.8
Sex	Female	40	44.4
	Male	50	55.6
Age category	Below 25	6	6.7
	25–40	39	43.3
	41–55	39	43.3
	56 and above	6	6.7
Education level	No formal education	2	2.2
	Primary	10	11.1
	Secondary	32	35.6
	Certificate	11	12.2
	Diploma	18	20.0
	Bachelor's Degree	16	17.8
	Above Degree	1	1.1
Number of years in pig farming	<1 year	4	4.4
	2–5 years	37	41.1
	6–10 years	36	40.0
	Over 10 years	13	14.4

4.2 Farm Management and Animal Characteristics

All 90 farms (100%) practised intensive (confined housing) pig production. Crossbreeds were the dominant type kept (n = 82, 91.1%). The most important reasons for choosing the breed were good mothering ability (n = 71, 78.9%), adaptability to the local context (n = 68, 75.6%), and temperament (n = 66, 73.3%). The majority of farmers sourced breeding stock from fellow farmers (n = 75, 83.3%). Feeding was mainly based on swill (n = 68, 75.6%) and commercial feeds (n = 48, 53.3%). Most farmers fed lactating sows twice per day (n = 72, 80.0%), though only a minority had a creep feeding area (n = 24, 26.7%). Herd sizes were generally small, with most farms keeping 1–3 breeding sows/gilts (n = 87, 96.7%).

Table 3: Farm Management and Herd Characteristics (N=90)

Characteristic	**Category**	**Frequency (n)**	**Percentage (%)**
Pig production system	Intensive (confined housing)	90	100.0
Pig breeds kept	Crossbreeds	82	91.1
	Local	7	7.8
	Exotic	1	1.1
Reasons for choosing the breed (multiple responses)	Good mothering ability	71	78.9
	Adaptability to the local context	68	75.6
	Temperament	66	73.3
	Meat quality	43	47.8
	Faster growth rates	37	41.1
	High maturity weight	27	30.0
	High prolificacy	24	26.7
	Size	19	21.1
	Skin colour	2	2.2
Source of breeding stock	Fellow farmers	75	83.3
	Other	10	11.1
	Breeding farms	5	5.6
Influence of pork buyers to preference of breeds kept	No	88	97.8
	Yes	2	2.2
Main source of breeding information	Experience and personal observation	33	36.7
	Success of neighbouring farmers	31	34.4
	Extension officers	13	14.4

	Media (TVs, Radio, social media)	12	13.3
	Other	1	1.1
Feed types used (multiple responses)	Swill	68	75.6
	Commercial feeds	48	53.3
	Market wastes	34	37.8
	Crop residues	27	30.0
Frequency a lactating sow feeds per day	2 times	72	80.0
	1 time	10	11.1
	3 times	8	8.9
Presence of creep feeding area	No	66	73.3
	Yes	24	26.7

Table 4: Herd Structure by Animal category (N=90)

Animal Category	Category	Frequency (n)	Percentage (%)
Breeding sows/gilts	1–3	87	96.7
	More than 3	3	3.3
Males (Boars)	None/Hire	37	41.1
	1–2	51	56.7
	More than 2	2	2.2
Females (Sows and Gilts)	Less than 5	84	93.3
	5–6	5	5.6
	More than 6	1	1.1
Weaners	Less than 5	50	55.6
	5–10	35	38.9
	More than 10	5	5.6
Growers	Less than 5	73	81.1
	5–10	16	17.8
	More than 10	1	1.1
Piglets	Less than 5	43	47.8
	5–10	39	43.3
	More than 10	8	8.9

4.3 Characterization and Assessment of Key Reproductive Performance Parameters of Sows

A total of **151** breeding sows across 90 farms were analysed. All farms operated under intensive production systems. The majority of breeding's were by natural service (**NS**: n = 129, 85.4%), while artificial insemination (**AI**) accounted for 22 breeding's (14.6%). Overall, reproductive performance was moderate. Sows had a mean parity of 1.85 (median = 2), indicating that the data largely captured early parities. On average, sows gave birth to 9.46 total piglets (9.09 born alive), with a low mean stillbirth rate of 0.39 per litter. Pre-weaning mortality averaged 7.03%, but showed high variability (median = 0%, range 0–100%), reflecting that many litters had no mortality while a few experienced very high losses.

The average number of piglets weaned per litter was 8.78. Age at weaning averaged 46 days (commonly around 45 days). The weaning-to-service interval averaged 55.76 days, while the inter-farrowing interval was 7.13 months. This translated into a litter index of approximately 1.67 and an average of 14.09 piglets weaned per sow per year. Non-productive days averaged nearly 95 days per sow.

Table 5: Reproductive performance parameter by breeding sows (N=151)

Parameter	Mean	SD	Median	IQR	Min	Max	Range
Parity	1.85	0.84	2.00	1.00	1	4	3
Total born	9.46	1.95	9.00	3.00	1	13	12
Born alive	9.09	1.88	9.00	2.00	1	13	12
Still births	0.39	0.65	0.00	1.00	0	2	2
Pre-weaning mortality (%)	7.03	14.20	0.00	11.10	0	100	100
Age at weaning (days)	46.05	10.88	45.00	15.00	0	74	74
Weaned piglets	8.78	4.66	8.00	3.00	0	60	60
Weaning-to-service interval (days)	55.76	15.23	60.00	15.00	0	180	180
Inter-farrowing interval (months)	7.13	0.86	7.20	0.59	0	11.3	11.3
Litter index	1.67	0.19	1.67	0.15	0	1.9	1.9
Piglets weaned per sow per year	14.09	3.56	13.79	3.78	0	23.2	23.2
Non-productive days	94.99	17.76	98.00	19.00	0	196	196

4.4 Incidence and Likely Etiology of Pre-weaning Piglet Mortality in Breeding Herds

4.4.1 Incidence of Pre-weaning Piglet Mortality in Breeding Herds

More than half of the farmers (n = 49, 54.4%) reported experiencing piglet mortalities before weaning, while 41 farmers (45.6%) did not.

Table 6: Incidence of pre-weaning mortality among study farms (N=90)

Mortality Status	Frequency (n)	Percentage (%)
Absent	41	45.6
Present	49	54.4
Total	**90**	**100.0**

4.4.2 Etiology of pre-weaning piglet mortality in breeding herds

Pre-weaning piglet mortality was common, affecting over half of the farms. The majority of deaths occurred in the first week of life, particularly within the first 2 days. The most frequently reported causes were diarrhea and crushing by the sow ($p>0.001$). There was no statistically significant association between cannibalism($p=0.358$), floor type ($p = 0.713$).) and the occurrence of pre-weaning mortality.

Table 7: Age at mortality, reported causes and floor type among farms that experienced pre-weaning piglet mortality (N=49)

Variable	Proportionate Mortality n/49 (%)	χ^2	P-value
Age at mortality			
0–2 days	34 (69.4)	15.06	**<0.001**
3–7 days	23 (46.9)	25.85	**<0.001**
8–14 days	12 (24.5)	11.59	**0.001**
More than 14 days	9 (18.4)	8.37	**0.004**
Related Conditions			
Crushing by the sow	19 (38.8)	20.15	**<0.001**
Diarrhea	21 (42.9)	22.92	**<0.001**
Congenital defects	9 (18.4)	8.37	**0.004**
Predation	7 (14.3)	6.35	**0.012**
Cannibalism	1 (2.0)	0.85	0.358
Starvation	0 (0.0)	-	-
Floor type		1.37	0.713
Concrete floor	19 (38.8)		
Earthen floor	3 (6.1)		
IMO bed	7 (14.3)		
Wooden floor	20 (40.8)		

CHAPTER FIVE: DISCUSSION

5.1 Introduction

This study evaluated the reproductive performance of breeding sows and the prevalence and likely causes of pre-weaning piglet mortality under intensive and semi- intensive production systems in selected parishes of Makindye Division, Kampala District. The findings provide insights into the productivity and challenges faced by small-scale intensive pig farmers in an urban and peri-urban setting in Uganda.

The majority of respondents were male farm owners with secondary or higher education and moderate experience (2–10 years) in pig farming. This profile is consistent with studies in peri-urban Kampala, where pig farming is often managed by relatively educated individuals seeking supplementary income (Nabikyu & Kugonza, 2016; Okello et al., 2015). All farms operated under intensive confined housing, with crossbred pigs dominating. Farmers primarily selected breeds for good mothering ability, adaptability, and temperament, while sourcing stock from fellow farmers. Feeding relied heavily on swill and commercial feeds as supplements. These practices reflect typical resource-constrained urban pig production systems in East Africa.

5.2 Sow Parity and Litter Size

Sows in this study had a mean parity of 1.85 (median 2), indicating that the sampled population was dominated by gilts and young sows still early in their productive lifespan. Litter size and piglet survivability typically rise through the first three to four parities before declining in older sows (Corrales-Hernández et al., 2025; Klimas et al., 2020), so a herd this young would be expected to under-perform its own long-run potential. (Babigumira et al., 2023) working with smallholder farmers in Hoima and Kamuli districts, similarly found that parity significantly influenced both the number of piglets born alive and the number weaned, and that increasing the proportion of Modern European ancestry in a sow's pedigree added a further 2.4 piglets weaned on average. The low parity structure observed here may reflect either a young, expanding sow population or a high replacement rate, both plausible in an urban, land-constrained system where herd sizes were capped at 1-3 breeding sows on 96.7% of farms.

Total litter size averaged 9.46 piglets born (9.09 born alive), with stillbirths remarkably low at 0.39 per litter. This figure sits close to the most recent reproductive performance study conducted in Kampala, in which (Okello et al., 2015) recorded 10.53 total born and 9.84 born alive, an agreement suggesting that the crossbred genetics (predominantly Large White × Landrace types) and confined management common to Kampala's peri-urban belt support broadly similar prolificacy regardless of which parishes are sampled. Compared with the wider East African region, the litter size recorded here exceeds the 7.8 recorded under free-range western Kenyan conditions (Kagira et al., 2010), and is markedly higher than the 7.2–7.5 figures typical of Nigerian smallholder and institutional herds (Abah et al., 2019; Abonyi et al., 2012; Ate & Oyedipe, 2011).Against the hyper prolific commercial genetics in the West, where above 15 piglets are averagely born alive per litter is a now routine (Sanz-Fernández et al., 2024), Makindye's sows remain a distinctly tropical, smallholder-to-intensive figure respectable within the region but way below the ceiling achieved by modern breeding programmes.

5.3 Age at Weaning and Weaning-to-Service Interval

Piglets in this study were weaned at a mean age of 46.05 days, later than the 40.2 days reported for intensive systems in Nigeria (Abah et al., 2019), but somewhat earlier than the 54.5 days recorded in Kampala by (Okello et al., 2015). Weaning-to-service interval (WSI) averaged 55.76 days, considerably longer than both the Nigerian figure (39.4 days) (Abah et al., 2019) and the Kampala figure (49.9 days) (Okello et al., 2015), and far beyond the near-immediate WSI (5-7) days expected in well-managed commercial units. Since the IFI is essentially the sum of gestation length, lactation length (age at weaning) and WSI, a late-weaning and a longer WSI such as this compounds directly into a longer interval between litters and fewer litters produced per sow per year. This combination of comparatively late weaning and an unusually long WSI observed here points to the weaning-to-conception window, rather than gestation or lactation length, as the primary inefficiency in the reproductive cycle of Makindye breeding sows, consistent with the conclusion drawn by (Lañada et al., 1999) for smallholder sow farmers in the Philippines, where the non-productive period after weaning was identified as the principal area requiring intervention relative to international standards.

5.4 Inter-Farrowing-Interval and Litter Index

The inter-farrowing interval (IFI) recorded in this study, 7.13 months, is virtually identical to the 7.2-month figure reported for peri-urban Kampala by (Okello et al., 2015), reinforcing that this appears to be a genuine feature of the local production system rather than a sampling artefact. However, it is longer than the IFI (6.2 months) documented in Nigeria (Abah et al., 2019) and (6.4 months) recorded in Kenyan smallholder systems (Wabacha et al., 2004). Commercial systems, in contrast, typically achieve an IFI close to 5 months, permitting over 2 litters per sow per year. The litter index calculated in this study, 1.67, falls below both the 1.8 reported (Okello et al., 2015) and (2.2-2.5) commercial benchmarks, and it is the arithmetic consequence of the extended weaning age and WSI discussed above. Reducing non-productive days which averaged nearly 95 days per sow in this study would lift the reproductive performance substantially without any change in litter size or genetics.

5.5 Number of Piglets Weaned Per Sow Per Year

The mean of 14.09 piglets weaned per sow per year (NPWSY) recorded in this study is markedly higher than the 8.1 reported for intensive Nigerian herds (Abah et al., 2019). It however, falls short of the approximately 20 piglets weaned per sow per year that FAO extension guidance identifies as achievable by well-managed sows of improved breed under smallholder conditions (Dietze, 2011), this represents a small portion of the productivity of current commercial units' standards, where the modern industry target is close 30 piglets weaned per sow per year and rising (Muns et al., 2016). The gap is best explained not by litter size, which compares favourably with regional benchmarks, but by the extended WSI and consequent low litter index described above i.e. Makindye's sows produce competitively sized litters too infrequently.

5.6 Pre- Weaning Piglet Mortality: Incidence, Timing and Likely Etiology

Pre-weaning mortality averaged 7.03% across all litters recorded (median 0%, range 0–100%), a figure that appears strikingly favourable set against nearly every comparable regional study i.e.(Okello et al., 2015) recorded a pre-weaning piglet mortality of roughly 16% for peri-urban Kampala farms; (Biryomumaisho & Ogalo, 2007), working directly with in Kampala district, recorded an overall mortality of 32.6%; (Wabacha et al., 2004), reported a median of 10% for smallholder Kenya; (Abah et al., 2019) recorded 31% for Abuja, Nigeria; (Abonyi et al., 2012) documented 17.75% neonatal mortality in Nsukka, Nigeria; and (Atawalna et al., 2021) reported 18.7% on commercial Ghanaian farms. Commercial industry pre-weaning piglet mortality itself typically remains in the 10–20% band even under well-resourced conditions (Muns et al., 2016). The wide range and low median obtained in the present dataset i.e. 45.6% (n = 41) of sampled farms reported no mortality at all in the litter assessed suggests that farmer-recall reporting, on which this cross-sectional survey depended, is more likely to understate mortality than the direct, longitudinal, farm-visit methods used by (Wabacha et al., 2004) and (Abonyi et al., 2012), both of whom monitored litters prospectively rather than relying on a single retrospective interview. The true pre-weaning mortality burden in Makindye Division is therefore probably closer to the regional norm than the raw mean of 7.03% suggests, and should be interpreted with this limitation in mind rather than as evidence of genuinely superior piglet survival.

Among the 49 farms (54.4%) that reported experiencing PWM, mortality was concentrated early in life; 69.4% of affected farms reported deaths within the first two days, 46.9% within (3-7) days, and only 18.4% beyond fourteen days. This pattern corresponds closely to the wider literature on neonatal pig mortality, in which 50 to 80% of pre-weaning deaths occur during the first week of life and the first 72 hours after birth represent the single most critical period (Koketsu et al., 2021; Muns et al., 2016) and mirrors the specific finding of (Abonyi et al., 2012) that 87.8% of neonatal deaths in their Nsukka, Nigeria sample occurred within the first 5 days.

The leading causes reported in this study were diarrhea (42.9% of affected farms) and crushing by the sow (38.8%), followed by congenital defects (18.4%), predation (14.3%), and, at low and statistically non-significant levels, cannibalism (2.0%) and starvation (0%). This likely etiology profile differs from most of the comparative literature, in which crushing or maternal overlay is consistently the single leading cause: 31.3% in (Abah et al., 2019), 29.3% in (Abonyi et al., 2012), and a similarly dominant position in (Wabacha et al., 2004). The prominence of diarrhea ahead of crushing in the present study points toward hygiene, colostrum management, or enteric pathogen pressure as a locally significant driver of mortality. Crushing nevertheless remained the second most frequently reported cause, in line with the broader literature identifying inadequate farrowing supervision, absence of creep feeding areas, and sow mothering behaviour as persistent risk factors across production systems (Edwards & Baxter, 2015).

Floor type, i.e. concrete, earthen, improved organic-matter (IMO) bed, or wooden, showed no statistically significant association with mortality occurrence in this study ($\chi^2 = 1.37$, $p = 0.713$). This result is corroborated by (Kilbride et al., 2012), who compared farrowing crates, indoor loose pens and outdoor arcs across 112 commercial English farms and found that overall pre-weaning mortality did not differ significantly by housing type, because farrowing crates reduced crushing deaths while other causes of mortality increased correspondingly, leaving total mortality broadly unchanged. The absence of a floor-type effect in the present study is therefore consistent with wider evidence that the physical substrate of the farrowing area, considered alone, exerts less influence on piglet survival than farrowing supervision, sow behaviour, colostrum intake and birth weight (Edwards & Baxter, 2015), factors this cross-sectional design was not able to measure directly.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS AND LIMITATIONS OF THE STUDY

6.1 Conclusion

This study characterized the reproductive performance of breeding sows and determined the incidence and likely etiology of pre-weaning piglet mortality in intensive production systems within selected parishes of Makindye Division, Kampala District.

The findings indicate moderate reproductive performance, with sows averaging 9.46 total piglets born and 8.78 weaned per litter, translating to approximately 14.09 piglets weaned per sow per year. Pre-weaning piglet mortality affected over half (54.4%) of the farms, with the majority of deaths occurring in the first week of life (particularly 0–2 days). The leading reported causes were diarrhea and crushing by the sow.

These results highlight both the potential and the existing constraints in urban and peri-urban pig production in Kampala.

6.2 Recommendations

Farmers should:

- Prioritize shortening the weaning-to-service interval (currently averaging 55.76 days, against (5-7) days in Western intensive commercial systems) by monitoring sows closely for oestrus signs after weaning, securing reliable boar or AI access within about a week of weaning, and improving post-weaning nutrition to hasten the return to service. This single change offers the most direct route to more litters, and therefore more piglets, per sow per year.

- Give hygiene and colostrum management at least equal priority to crushing prevention. Diarrhoea (42.9% of affected farms), not crushing (38.8%), was the leading reported cause of pre-weaning death in this study — a pattern that differs from most published African data and warrants dedicated attention to sanitation, wet/dry bedding management, and ensuring piglets suckle colostrum within hours of birth.

- Continue supervising farrowing and providing creep feeding areas to reduce crushing, but avoid investing in floor-type changes (concrete versus earthen versus wooden) as a stand-alone mortality intervention, since floor type showed no significant association with mortality in this study (p = 0.713). Resources should better be directed at supervision, colostrum intake, and good hygiene management.

- Keep simple, litter-level written records of farrowing dates, litter size, weaning dates, service dates, and any piglet deaths with their likely cause. The wide, recall-dependent range in this study's mortality data (45.6% of farms reporting none, alongside a few reporting total loss) limits farmers' own ability to identify which sows, seasons, or practices are driving losses.

- Manage parity structure deliberately: retain proven sows through at least their second or third litter rather than culling early, since litter size and piglet survival typically improve after the first parity, and the young parity structure observed here (mean 1.85) may itself be depressing average performance below the herd's real potential.

Extension Services and Veterinary Authorities should:

- Deliver targeted training on oestrus detection and post-weaning rebreeding management specifically, rather than general reproductive-management training, since the weaning-to-service interval is the parameter most responsible for Makindye Division's reproductive underperformance relative to both regional and commercial benchmarks.

- Investigate the specific pathogens responsible for the diarrhea-led mortality pattern identified in this study (for example through diagnostic sampling for enterotoxigenic Escherichia coli and related enteric agents) and issue hygiene and colostrum protocols tailored to the finding, rather than assuming crushing is the dominant risk as in most prior regional studies.

- Promote low-cost, non-structural interventions like supervised farrowing, creep feeding areas installation, colostrum management and sanitation ahead of costly housing or floor retrofits, given that floor type was not associated with mortality in this study.

- Distribute simple record-keeping templates farmers can realistically maintain, to reduce reliance on recall and improve the accuracy of any future monitoring or survey work in the area.

Researchers and Policymakers should:

- Commission a longitudinal, farm-visit-based follow-up study to obtain an accurate pre-weaning mortality estimate. The cross-sectional recall-based mean of 7.03% obtained here is markedly lower than every comparable Kampala, East African, and West African study (16–32.6%) and is best treated as an underestimate pending confirmation by prospective monitoring.
- Evaluate interventions aimed specifically at reducing the weaning-to-service interval and non-productive days (currently averaging close to 95 days per sow), since these, rather than litter size, which is already competitive regionally, are the parameters furthest from achievable benchmarks.
- Support microbiological investigation of diarrhea-related piglet mortality in Kampala's peri-urban pig herds, to establish whether this reflects a locally distinct disease pattern relative to the crushing-dominated profiles reported in most of the wider literature.

6.3 Limitation of The Study

- Sample size shortfall: the Cochran formula-based calculation set a minimum requirement of 317 sow-level records, but the study obtained reproductive data from only 151 breeding sows across 90 farms. This reduced the precision of the estimates and the statistical power available for sub-group comparisons, particularly for pre-weaning mortality categories with very small cell counts (e.g., cannibalism, n = 1; starvation, n = 0).
- Cross-sectional, recall-dependent design: reproductive and mortality data relied largely on farmer recall and available farm records rather than prospective, farm-visit-based monitoring of each reproductive cycle. This is a plausible explanation for why the pre-weaning mortality mean recorded here (7.03%) falls far below every comparable Ugandan and regional estimate (16.3–32.6%), suggesting under-reporting rather than genuinely superior piglet survival.
- Lay diagnosis of mortality causes: causes of piglet death (e.g., diarrhoea, crushing, congenital defects) were based on farmer observation rather than veterinary examination

or laboratory confirmation, so the aetiological classification, particularly the pathogen(s) underlying the diarrhoea-led mortality pattern, remains presumptive.

- No seasonal coverage: data were collected at a single point in time, so the influence of Kampala's bimodal rainfall and temperature-humidity fluctuations on farrowing duration, stillbirth risk and piglet survival, established elsewhere in the literature, could not be assessed.

6.4 Areas of further research

- A longitudinal, farm-visit-based cohort study following individual sows and litters prospectively from breeding through weaning, to generate a pre-weaning mortality estimate that does not depend on farmer recall.
- A larger, randomly sampled survey spanning all, or a randomised subset, of Makindye Division's 21 parishes, to establish a statistically representative divisional baseline rather than one drawn from three purposively selected parishes.
- Microbiological and diagnostic investigation of the pathogens responsible for the diarrhoea-led mortality pattern identified in this study, to confirm whether it reflects a locally distinct disease profile relative to the crushing-dominated pattern reported in most regional literature.
- Intervention studies evaluating structured post-weaning oestrus-detection and rebreeding protocols, given that the weaning-to-service interval was identified as the parameter furthest from international benchmarks.

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APPENDICES

Appendix 1: Structured Questionnaire

STRUCTURED QUESTIONNAIRE FOR EVALUATION OF REPRODUCTIVE PERFORMANCES OF BREEDING SOWS WITHIN SELECTED PARISHES OF MAKINDYE DIVISION, KAMPALA DISTRICT.

I invite you to participate in the above research study conducted by **KYEYUNE PETER PAUL** from **College of Veterinary Medicine Animal Resources and Biosecurity of Makerere University.** The goal is to collect data on the respondent's demographics. Farm characteristics, breeding methods and pre-weaning mortality rate so as to better understand the swine productivity within this area.

Participation is entirely voluntary and the information given will be confidential and strictly used for academic purposes. By proceeding with this interview, you indicate your consent to participate.

Farm ID.

__________________________.

Date of interview: ___/___/_____.

SECTION A: Respondent Demographics (tick the most appropriate).

1. Respondent: Farm owner_______. Care taker______. Both_______.
2. Age category: (Below 25) ____. (25-34) _____. (35-44) _____. (45 and above) ____.
3. Sex: Female_______. Male______.
4. Education Level: No formal education______. Primary_______. Secondary______. Certificate_____. Diploma_____. Bachelor's Degree_____. Above Degree _____.
5. Number of Years in Pig Farming: (< 1) ___. (2-3) ___. (4-6) ___. (Over 6) ___.
6. Parish: _______________.

SECTION B: Farm Characteristics.

1. **Number of pigs on the farm: _______.**
2. **Herd structure:**
   - Males (boars) ____.
   - Females (sows and gilts) ___.

- Weaners: ____.
- Growers: ____.
- Piglets: ____.

3. **Number of Breeding Sows/Gilts: ______.**
4. **Pig Breeds (tick the most appropriate):**

A. Exotic ____. B. Local _____. C. Crossbreeds_____.

5. **Pig Production System (tick the most appropriate):**
   A. Intensive (confined housing) ____.
   B. Semi-Intensive ____.
   C. Extensive (free-range) ______.
6. **Feeding Types (tick more than one where possible):**
   A. Commercial Feeds______.
   B. Swill ______.
   C. Crop residues _____.
   D. Market wastes ______.
7. **Number of Times a Lactating Sow Feeds in a Day ____.**
8. **Presence of Creep Feeding Area_____. (Observational)**

A. Yes. B. No.

SECTION C: Drivers for Farmers Preferred Breed and Trait Preferences.

1. **Pig Breeds Currently Being Reared (tick the most appropriate).**

A. Large white.
B. Land race.
C. Duroc.
D. Pietrain.
E. Local.
F. Crosses (specify) ______________.
G. Unknown to the farmer.

2. **Why the Chosen Breed. (Rank the Best Four) 1. ___ 2. ___ 3. ___ 4. ____**

A. High prolificacy
B. Good mothering ability.

C. Faster growth rates.

D. High maturity weight.

E. Skin colour.

F. Size.

G. Temperament.

H. Meat quality.

I. Adaptability to the local context.

3. Source of Breeding Stock (tick the most appropriate).

A. Fellow farmers.

B. Breeding farms.

C. Government programs.

D. NGO's.

4. Does the Preference of Pork Buyers Influence the Breed You Keep? (tick the most appropriate).

A. Yes.

B. No.

5. Source of Information About the Best Breeds to Keep (tick the most appropriate).

A. Extension officers.

B. Media (TVs, Radio, social media).

C. Experience and personal observation.

D. Success of neighbouring farmers.

SECTION D: Reproductive Performance Parameters.

Sow ID.	Parity	Breeding Method (AI/NS)	Litter size			PWM	AAW (Days)	WSI (Days)	NPD (Days)	IFI (Months)	Litter index	NPWPY
			TB	BA	SB							
FARM AVERAGES												

KEY.

- **IFI:** Inter Farrowing Interval.
- **WSI:** Weaning to Service Interval.
- **NPD:** Non- Productive Days.
- **PWM:** Pre-Weaning Mortality.
- **AAW:** Age at Weaning.
- **NPWPY:** Number of Piglets Weaned Per Sow Per Year.
- **TB:** Total Born.
- **BA:** Born Alive.

AI: Artificial Insemination.

NS: Natural Service.

SB: Still Birth.

SECTION F: Likely Etiology of Pre-Weaning Mortalities.

1. **Do You Experience Any Piglet Mortalities Before Weaning?**
    - A. Yes.
    - B. No.
2. **Age at Which These Mortalities Occur.**
    - A. (0 – 2) days.
    - B. (3 – 7) days.
    - C. (8 – 14) days.
    - D. >15 days to weaning.
3. **Likely Observed Cause of Death.**
    - A. Crushing by the sow.
    - B. Diarrhea.
    - C. Congenital defects.
    - D. Starvation.
    - E. Predation.
    - F. Cannibalism.
    - G. Others (specify). _____________.
4. **Floor Type.**
    - A. Wooden floor.
    - B. Concrete floor.
    - C. IMO bed.
    - D. Earthen floor.

<u>END OF QUESTIONNAIRE THANK YOU FOR YOUR PARTICIPATION!</u>

Data Entry Check: *☐ Complete ☐ Partial (Specify Missing: _____________)*

Follow-Up Needed: *☐ Yes (Date: ______________) ☐ No*