

# Current Status and Potential Opportunities for Uganda's Pig Sub-Sector: A Review

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## ABSTRACT

Pig production is one of the most important livestock sub-sectors in the agricultural economy of Uganda. However, pig production is not a priority enterprise in the government endeavors to uplift livelihoods of Ugandans, which has deterred the sub-sector from realizing its full potential. This review explores opportunities that pig farmers and policy makers could exploit to improve pig production in the country. Since gender inclusivity is pivotal in global agricultural development, the review examines the level of gender inclusivity in Uganda's pig production, the key constraints to pig production, and opportunities that could boost growth of the sub-sector. The review has identified that there is an increase in women participation in pig production, which portrays realization of faster growth of Uganda's pig production. This faster growth might however be deterred by frequent African Swine Fever (ASF) outbreaks, high cost of feeding and low quality of feed materials due to aflatoxin contamination. Offensive smell from pig houses could also constrain pig production especially in densely populated areas. Potential opportunities for Uganda's pig production include use of alternative feeds like black soldier fly larvae and biochar. Black soldier fly larvae grow on readily available organic wastes and are rich in proteins while biochar improves the immunity of pigs. Nixtamalization, a process involving the treatment of maize with an alkaline solution to reduce aflatoxin levels, could be explored to mitigate feed contamination while indigenous microorganism solution could be applied on deep litter beddings to reduce offensive odor in pig house. In conclusion, the study observed that Uganda has untapped opportunities that, once utilized, could improve pig production. These, if adopted, could contribute to a swifter take-off in the pig sub-sector and ensure that future domestic demand for pork is met by our own production. The potential alternatives are also applicable to pig production in any developing country.

**Keywords:** Aflatoxins, Gender inclusivity, Indigenous microorganisms, Nixtamalization, Black Soldier Fly Larvae

## 1.0. INTRODUCTION

Pig production is one of the most important livestock sub-sectors in the agricultural economy of Uganda (Mutua et al., 2020; Nantima et al., 2015). The importance of pig sub-sector is realized in Uganda's high pork consumption levels of up to 3.4kg/capita (FAO, 2021), which makes pig production a potential food security enterprise, and the fact that the pig production has the potential to lift Ugandans out of poverty (Kasima et al., 2021a). The current pig production level is, however, not sufficient to meet the country's demand for pork (FAO, 2021). Projection by FAO (2017), for example, indicates that Uganda's annual pork consumption will remain the highest in East Africa by 2050. Therefore, meeting the current and projected demand for pork calls for a robust increase in pig production.

Unfortunately, Uganda's policy framework has no considerations for sustaining, and/or even improving pig production (Mutua et al., 2020; Twine and Njehu, 2020). According to FAO (2019), cattle and poultry are the "essential" livestock species in Uganda. These are considered the priority strategic livestock species in Uganda's agricultural strategic plan (MAAIF, 2017). The growth of Uganda's pig sub-sector has, therefore, grappled all through with minimal support from the government. With this state, the sector is prone to missing opportunities of the ready market for pork both locally and internationally. Efforts to improve pig production have persistently realized limited success, especially among the smallholder farmers (Lukuyu and Ouma,

2022), who produce most of the country's pork (Atherstone et al., 2019).

There is a large body of research existing on the potential options that could be used to sustain pig production, many of which are less employed in Uganda's pig production. This current review, thus, critically examines Uganda's pig production with key insights in the potential areas that could be exploited to hasten the growth of the country's pig sub-sector. First, the review unearths the current level of gender inclusivity in pig production as this is key to development of the sector. The review then examines the key challenges to Uganda's pig production, and the potential opportunities that are applicable to Uganda's situation. It is envisaged that this review will give direction to efforts by research institutions, which have been at the forefront in the endeavors to improve Uganda's pig production. The review will also contribute to ensuring that a forward trend in the sectoral growth is achieved and sustained. More importantly, the opportunities for improving pig production presented in the current review are also applicable in any developing country.

## 2. GENDER AND PIG PRODUCTION IN UGANDA

Although gender dynamics in Uganda's pig sub-sector are understudied, the existing literature shows increasing women participation in pig production. Due to the draught nature of most pig handling activities, piggery was initially an enterprise for

for male farmers (Mugonya et al., 2019). However, with the increasing number of female-headed households in Uganda, women participation in pig production is on the rise (Kungu et al., 2019). This is because of the low investment and small space requirements of pig production enterprises which makes it cheaper even for the women to take up pig production.

Surprisingly, even in male-headed households, the wives have gained a pivotal role in pig production, especially in initiating pig production enterprises by procuring the first stock (Dione et al., 2022). When men initiate pig production in a household, they do consult their wives on the numbers to rear, especially if feeds are to be grown on the farmland (Lukuyu et al., 2020). The reason behind this is that females are always key in feeding and producing feeds for pigs within a household (Dione et al., 2020).

In the urban parts of central Uganda, Dione et al. (2022) reported a larger number of female-owned than male-owned farms. These females, however, hire males to work on their farms (Achandi et al., 2021). Even in Northern Uganda, a higher percentage of female pig farmers has been reported by Birungi et al. (2020). However, female pig farmers in the Northern Uganda have smaller pig herds than those of their male counterparts. This could be because of the limited access to resources by females, which is a general issue across cultures in Uganda (Carter et al., 2017; Mugonya et al., 2019). In circumstances where a husband and the wife own pigs collectively, a shared responsibility is ensured in activities like

feeding where the man, wife and children in the household get involved (Lukuyu et al., 2020).

With the increasing women participation in Uganda's pig sub-sector, a hastened progress may be expected. This is because women are integral in agricultural development (Ganta, 2021; Belay and Oljira, 2019; Dos et al., 2018; Sell and Minot, 2018). To maintain this speculated growth, however, the most constraining issue of limited access to resources, especially land, among female farmers should be addressed.

On the other hand, the high female participation in pig production does not mean that male involvement and contribution is overlooked. And the astoundingly high female contribution to pig production has not solely been obtained without men. Due to the country's cultural setting, most of the land is still in the ownership of male farmers, and many of the females are just allocated pieces on their husband's premises without full ownership. Additionally, males own larger herd sizes and are more intensive than female farmers, hence their efforts are inseparable from the growth of Uganda's pig sub-sector. Furthermore, activities like sty construction and health management are still conducted by the males besides them sharing in the feeding and other activities, which women mostly get involved in (Dione et al., 2020). Based on these facts, it is evident that the future of Uganda's pig sub-sector will be determined by the continual harmony among the male and female contributors.

### 3. KEY CHALLENGES IN UGANDA'S PIG SUB-SECTOR

Diseases, especially African swine fever (ASF) are among the most constraining factors to the growth of pig production. African swine fever is the most devastating disease in Uganda's pig production and is endemic in the country (Wanyama and Leitner, 2019; Aliro et al., 2022; Ndoboli et al., 2021). Since ASF is incurable with no vaccine as yet, it has demeaned management efforts and raised great concern in pig production. Yes, there are worm burdens and other disease incidences, but ASF has been more severely devastating to the country's pig sub-sector (Ibrahim et al., 2021). African swine fever is characterized by massive deaths (Aliro et al., 2022) with potential of 100% mortality, making it very fatal to the sub-sector. Its importance has aroused control efforts, especially biosecurity awareness campaigns (Dione et al., 2020; Chenais et al., 2019), and if adhered to, could contribute to efforts to save the country's pig sub-sector. The uptake of these control measures will, however, be possible with extensive sensitization of pig farmers and other stakeholders in the pig sub-sector. Thus, government intervention could augment the campaign towards embracing biosecurity measures against ASF. Among other serious disease cases scours, particularly in piglets (Obala et al., 2021), and high worm burden in pig herds (Ouma et al., 2021) should be given attention. Several indigenous practices have been employed in the control of worms and scours in pigs in India. For

example, mixing *Azadirachta indica* powder with water was reported as an effective purgative for worm infections (Doley et al., 2022). *Centella asiatica* extract was also appraised in curing scours in pigs (Doley et al., 2022; Borah et al., 2023). These interventions, however, are not documented as being employed in Uganda, yet they would contribute to improving herd health and performance. As for ASF, no indigenous practice has so far been reported to successfully eradicate it.

Although diseases seem to be threatening, farmers across the country have always complained of feeding as the most constraining factor to pig production (Dione et al., 2022; Kasima et al., 2021b; Okello et al., 2020). The feeding challenge is complex, being cocktailed with high costs of complete feeds, seasonality of alternative feedstuffs and limited knowledge in formulating feeds using locally available ingredients to meet the nutritional requirements of pigs (Babigumira et al., 2019; Oba et al., 2021; Okello et al., 2021). Another feeding challenge of increasing concern is the deteriorated quality of feeds, especially due to aflatoxin contamination (Nakavuma et al., 2022). It is quite unfortunate that little attention is given to mitigating aflatoxin contamination of ingredients during feed mixing, especially in maize where frequent cases of aflatoxins have been reported (Magala et al., 2022; Omara et al., 2021). This is of public health concern since maize and maize bran are the primary energy sources in pig diets in Uganda. In addition, the offensive smell from pig houses is also an emerging

problem of importance, especially with the increasing human population and hence closer proximity to piggery units. Therefore, options to reduce offensive odor from pig houses also need to be explored.

#### **4. POTENTIAL OPPORTUNITIES FOR IMPROVING PIG PRODUCTION IN UGANDA**

##### **4.1 Feeding option for Uganda's pig sub-sector**

There is potential of using alternative feed ingredients to develop low-cost balanced feeds for different categories of pigs to enhance performance (Carter *et al.*, 2015). Currently, there is evidence that use of some crop wastes in pig diets could improve performance of pigs and enhance the quality of pork on Ugandan market (Kasima *et al.*, 2023). More research has also appraised the diversity of locally available feedstuffs whose use has the potential to maintain and improve performance of pigs (Kungu *et al.*, 2019; Dione *et al.*, 2022; Lukuyu *et al.*, 2020; Dione *et al.*, 2020; Aliro *et al.*, 2022; Okello *et al.*, 2021). However, the use of some of these feedstuffs could be limited by their low protein content, being bulky, highly fibrous and their seasonal availability. Hence exploring other alternative low-cost protein-rich ingredients to augment these wastes is also necessary.

Among the trending potential protein-rich ingredients are the insect meals, which are also rich

sources of essential fatty acids. Of these, the black soldier fly larvae have attracted many researchers' attention and several reports have appraised it as having the potential to substitute the conventional protein sources (fishmeal and soybean meal) (Kasima *et al.*, 2023; Abd El-Hack *et al.*, 2020; Chia *et al.*, 2020; Biasato *et al.*, 2019). Fishmeal and SBM are expensive and couple as human food, hence their usage has always raised concern owing to the increasing food and nutritional insecurity. Consequently, FAO (2022) recommended that alternative protein sources be explored.

Although insects like black soldier fly larvae are cheap and potential alternative protein sources, their usage is understudied in Uganda. This is notwithstanding the fact that black soldier fly larvae use in pig diets is legally accepted in Uganda (Chia *et al.*, 2020). Black soldier fly larvae have a crude protein content ranging between 40- 61% (Hong and Kim, 2022) and can be raised on organic wastes (Chia *et al.*, 2020; DiGiacomo and Leury, 2019; Shumo *et al.*, 2019). Therefore, they can be cheaply reared to produce a low-cost protein meal to substitute fish meal and soybean meal. Moreover, partial or full replacement of fishmeal with black soldier fly larvae meal results in higher body weight and average daily gain of finishing pigs (Chia *et al.*, 2021). At 50% level of inclusion of black soldier fly larvae meal, Chia *et al.* (2021) reported the highest crude protein content of pork and enhanced potassium, iron, and zinc levels in *Longissimus dorsi* muscles.

Interestingly, black soldier fly larvae are a reliable source of lysine, the most limiting amino acid in pig diets (Crosbie *et al.*, 2020). Furthermore, the 88% lysine ileal digestibility of black soldier fly larvae meal is as high as for soybean meal lysine (89%) and greater than the 86% and 84% for fish meal and blood meal, respectively (Crosbie *et al.*, 2020). Consequently, black soldier fly larvae meal could serve as a substitute to the conventional protein sources in pig diets with no or minimal compromise to the performance of pigs. However, inclusion of black soldier fly larvae in pig diets should be done judiciously as it could lead to pork with enhanced saturated fatty acid content which could be hazardous to human health. This is especially important because black soldier fly larvae inherently biosynthesize myristic and palmitic acids (Lu *et al.*, 2022; Hoc *et al.*, 2020; Sprangers *et al.*, 2016). These two saturated fatty acids have particularly been victimized as having a positive association with cardiovascular diseases (Olivieri *et al.*, 2020; Ebbesson *et al.*, 2015).

Equally, other insects like silkworm, crickets, and housefly larvae could be potential options (Shah *et al.*, 2022) and their usage in pig diets need to be explored in Uganda. However, unlike black soldier flies, crickets are particularly consumed by humans and utilizing them for pig feed could imply competition. As for the silkworms, the country is promoting their rearing for fiber production, thus their utilization in pig feed production might be limited.

To further explore other cheap feeding alternatives, particularly for enhanced pork production, it has been found that the use of biochar could improve the eating quality of pork and health of pigs (Domaradzki *et al.*, 2022). Inclusion of biochar at 0.3% in finishing diets did not only improve the performance of pigs, but also boosted the immunity of the pigs and improved pork quality characteristics (Lao and Mbega, 2020). At 1-3% level of inclusion, Lao and Mbega (2020) reported an improvement in villi growth along the gastrointestinal tract. The effect of biochar on pig performance has been attributed to its positive influence on enzymatic digestion (Schubert *et al.*, 2021). Therefore, with the increasing volumes of agricultural wastes, which are a disposal burden (Kamoga and Ssekyewa, 2021), valorizing agricultural wastes for utilization in the feed industry could be a profitable venture. Furthermore, training farmers on the use of insect meals and biochar as feed ingredients in pig diets could serve to reduce feeding costs while resulting in the production of high-quality pork.

#### **4.2 Options for reducing aflatoxin contamination in feedstuffs**

Aflatoxin contamination in feeds and feed ingredients is a common issue in both homemade and small-scale processed feeds (Nakavuma *et al.*, 2020). This is intentional as both the farmers and small-scale processors of feeds aim to avoid total loss; thus, they decide to recycle moldy grains in animal feeds (Nakavuma *et al.*, 2020).

The primary culprit is maize and maize bran which are the major energy ingredients in pig feeds (Magala *et al.*, 2022; Omara *et al.*, 2021; Sserumaga *et al.*, 2020; Echodu *et al.*, 2019; Lukwago *et al.*, 2019).

Although a dearth of information exists quantifying aflatoxin concentrations in pork from pigs fed on aflatoxin-contaminated feeds, traces of aflatoxins have been reported in pork (Pleadin *et al.*, 2021). Thus, reducing aflatoxin concentrations in pig feeds and/or ingredients is necessary. This is due to the deleterious effects of increasing levels of aflatoxin consumption on the human physiological functioning (Peles *et al.*, 2021). Such effects are reported to be carcinogenic (Peles *et al.*, 2019), and thus potentially hazardous to pork consumers.

Among the unexplored options to reduce aflatoxin levels in Uganda is nixtamalization. Nixtamalization is a maize pre-treatment method, which has been used in the food industry in other countries to reduce aflatoxin levels in human food (Sunico *et al.*, 2021; Mngoli *et al.*, 2018). Precisely, previous studies on the potential of nixtamalization in reducing aflatoxin concentration have reported that the method significantly reduces the aflatoxin concentration (Mngoli *et al.*, 2018; Musita, 2020). During treatment, however, pH/temperature combinations are essential as reversals were suspected, especially in acidic conditions (Schaarschmidt and Fahl-Hassek, 2019). Hence more research should be undertaken on the effectiveness of nixtamalization for use in reducing aflatoxin concentration in feedstuffs for Uganda's pig industry.

## 5. SCALING UP THE USE OF INDIGENOUS MICROORGANISMS IN PIG HOUSING

Outstanding growth of the global pig industry is embedded in innovations (Ali *et al.*, 2018; Boyd *et al.*, 2019). Fortunately, Uganda is endowed with resources, which other countries with a robust pig sector have used. In the efforts to realize local options for reducing offensive smell from pig houses, research has proven that the use of Indigenous Microorganism (IMO) solution on deep litter beddings significantly reduces offensive smell (Nsubuga *et al.*, 2019). Besides reducing smell, application of IMO solution on deep litter beddings increases performance of pigs, particularly weight gain (Kidega *et al.*, 2021). The reason behind the improved performance is that the IMO hydrolyzes the cellulose in the litter material into simple sugars that are edible to pigs (Nsubuga *et al.*, 2019). Furthermore, raising pigs on IMO treated deep litter beddings results in pork with higher ratio of Unsaturated to saturated fatty acids (Kidega *et al.*, 2020). Currently, most pork on Ugandan market is high in saturated fatty acids (SFA) (Roesel *et al.*, 2019). Consumption of foods with high level of fatty acid saturation increases low-density lipoprotein (LDL)- cholesterol (Feingold, 2021) by reducing LDL clearance due to reduction in hepatic LDL receptors. Increasing levels of LDL- cholesterol has been related to CVD (Michos *et al.*, 2019; Ference *et al.*, 2018; Olivieri *et al.*, 2020; Ebbesson *et al.*, 2015).

Thus, there is an increased risk of cardiovascular complications among pork consumers in Uganda. Currently cardiovascular-related cases are the leading cause of death globally (Stadler & Marsche, 2021), and increasingly devastating in the developing world (Peiris *et al.*, 2021). In East Africa, Uganda has the second highest cases of cardiovascular complications, after Burundi (Mensah *et al.*, 2023). Although, the cause of the surge in these cardiovascular cases in Uganda is not documented, the high fatty acid saturation of pork on Ugandan market could be a contributor to these. Thus, with the potential of producing pork with enhanced unsaturated fatty acid using the IMO-deep litter system, the innovation needs to be scaled up, especially among smallholder farmers who produce most of the country's pork.

## 6. SUMMARIZED DISCUSSION

Pig production is a small yet increasingly important component of Uganda's livestock sector with potential of further growth. Currently, the growth realized in pig production has been obtained with minimal or even no government support, as pig production is not among the priority enterprises for economic development in Uganda.

One of the indicators of potential growth of pig sub-sector is the increasing gender inclusivity in pig production depicted by the increasing numbers of female pig farmers. Earlier authors in other countries with a fairly grown pig sector have realized that

increasing female participation in pig production is essential in the growth of the sector (Ganta, 2021; Belay and Oljira, 2019). However, it is observed that, with the cultural setting of Uganda, it is improper to overlook the men's contribution to pig production. This is because men own most of the essential resources and, even in female-owned pig enterprises, they make a significant contribution. Thus, a sustained harmony between the male and female farmers will be pivotal in the growth of Uganda's pig sub-sector.

Among the key challenges to growth of pig production, African swine fever and feeding are critically constraining pig enterprises. The endemicity of African swine fever and high mortality rate of up to 100% has threatened the country's pig sub-sector. As regards to feeding, the nutritionally-balanced feeds are expensive and most of the available alternative feed resources are seasonal with insufficient nutrients to solely sustain pigs. Exploring low-cost alternatives like black soldier fly larvae (Kasima *et al.*, 2023) and biochar (Domaradzki *et al.*, 2022; Lao and Mbega, 2020) could serve to mitigate the high feeding costs constraining pig production.

Utilizing crop wastes in growing black soldier fly larvae could offer a low-cost protein alternative to provide more balanced diets for pigs. The high crude protein composition in BSF larvae, followed by the high ileal digestibility of lysine comparable to SBM and higher than that of fishmeal and bone meal qualify black soldier fly larvae meal as suitable substitute Chia *et al.*, 2020; DiGiacomo and Leury, 2019; Shuma *et al.*, 2019; Crosbie *et al.*, 2020).



Crop wastes could also be valorized for producing biochar to use in feeding pigs. Furthermore, increasing concerns on aflatoxin contamination (Nakavuma *et al.*, 2020) of pig feeds and the offensive smell from pig houses should not be overlooked as they may greatly negate growth in pig production within the nearby future. In addition, aflatoxin accumulation in the food chain needs to be addressed due to its carcinogenic nature (Peles *et al.*, 2019). The potential of nixtamalization to reduce the aflatoxin concentration in pig feedstuffs should be explored (Sunico *et al.*, 2021; Mngoli *et al.*, 2018). This is especially important with maize the most common energy source in pig diets which has also reported the commonest cases of aflatoxin contamination in Uganda (Magala *et al.*, 2022).

Among the potential options to further increase pig production in the country, scaling up the use of indigenous microorganism (IMO) solution on deep litter floor would reduce the offensive smell from pig houses (Nsubuga *et al.*, 2019). Besides reducing the offensive smell, raising pigs on IMO treated deep litter improves performance, and the resulting pork has enhanced unsaturated fatty acid profile (Kidega *et al.*, 2020).

With the increasing urbanization of Uganda, it is projected that the consumption lifestyles may also change with time with a shift from veganism to high preference for meat and meat products. Thus, consumption of pork and pork products may increase (Faloye *et al.*, 2021; Saghaian and Mohammadi, 2018; Cockx *et al.*, 2019; Kim *et al.*, 2018). The

marketing strategies to be employed in the urban communities should consider presenting good quality pork and its products since most urban consumers are quality sensitive.

## 7. CONCLUSION

The importance of Uganda's pig sub-sector in the agricultural economy is astounding even with the absence of favorable policies. Fortunately, there is increasing female participation in pig production, an indicator of a progressing sector since females are integral in any agricultural development initiative. Furthermore, exploring less-costly feeding options, adopting strategies to reduce aflatoxin contamination in feedstuffs and scaling up the use of IMO on deep litter units could serve to hasten the growth of the sector even among the resource-constrained smallholder farmers. Once increased production is obtained, appropriate product orientation strategies should be employed to ensure that all niches of pork consumers are met with the right quality of pork.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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## AUTHORS' CONTRIBUTIONS

Kasima JS participated in writing original draft and editing, and visualization; Muyinza H, Mugonola B and Ndyomugyenyei EK participated in reviewing and editing of manuscript. All authors read and approved the final manuscript.

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