Proposal for the design of the future 
Masaka pig abattoir, Uganda

THE WAY FORWARD FOR PIG SLAUGHTERING IN MASAKA DISTRICT

Michael Handlos

March 2015
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## Abbreviations and definitions

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<th>Abbreviation</th>
<th>Definition</th>
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<tr>
<td>ABP</td>
<td>Animal By-Products</td>
</tr>
<tr>
<td>BOD</td>
<td>Biological Oxygen Demand</td>
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<td>BSE</td>
<td>Bovine Spongiform Encephalopathy (Mad Cow Disease)</td>
</tr>
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<td>CGIAR</td>
<td>Consultative Group on International Agricultural Research Consortium of International Agricultural Research Centers</td>
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<tr>
<td>COD</td>
<td>Chemical Oxygen Demand</td>
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<td>EAC</td>
<td>East African Community</td>
</tr>
<tr>
<td>GAHP</td>
<td>Good Animal Husbandry Practices</td>
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<td>GHP</td>
<td>Good Hygiene practices (in slaughterhouses)</td>
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<td>GMP</td>
<td>Good Management Practices (of slaughterhouses)</td>
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<tr>
<td>HACCP</td>
<td>Hazard Analysis and Critical Control Points</td>
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<tr>
<td>IFAD</td>
<td>International Fund for Agricultural Development</td>
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<td>ILRI</td>
<td>International Livestock Research Institute</td>
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<td>LIFSA</td>
<td>Livestock Competitiveness and Food Safety Project, Vietnam</td>
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<tr>
<td>MBM</td>
<td>Meat and Bone Meal</td>
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<tr>
<td>QA</td>
<td>Quality Assurance</td>
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<tr>
<td>Offal</td>
<td>Parts of a carcass such as blood, brain, heart, kidney, liver, pancreas, spleen, thymus, tongue and tripe, but excludes meat flesh, bone and bone marrow</td>
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<td></td>
<td><em>Inedible offal</em>, include hide or skin, hair, horns, teeth, fats, bone, ligaments and cartilage, feet, glands, blood, and lungs</td>
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<td></td>
<td><em>Edible offal</em>, livers, hearts, tongues, tails, kidneys, brains, sweetbreads (the thymus and/or pancreas gland, depending on an animal’s age), tripe (stomach), melt (spleen), chitterlings and natural casings (intestines), fries (testicles), rinds, head meat, lips, fats and other trimmings, blood, and certain bones</td>
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<tr>
<td></td>
<td><em>Red offal</em>: heart, kidney, liver, lungs, spleen, tongue</td>
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<td></td>
<td><em>White offal</em>: brains, marrow, testicles, fee</td>
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<td></td>
<td><em>Green offal</em>: Intestines, stomach</td>
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<td>PPP</td>
<td>Private Public Partnership</td>
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<td>SPVCD</td>
<td>Smallholder Pig Value Chain Development Uganda</td>
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<td>SS</td>
<td>Suspended Solids</td>
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Foreword

Comments on the terms of reference
1. Preparation of at least two design options for the slaughter facility: (a) For 20 pigs, (b) 50 pigs

During the discussion with the beneficiaries and ILRI staff it was decided that the layout of the slaughterhouse should foresee the construction of two bays, each for 25 pigs to be slaughtered per day. To reduce the initial investment costs only one bay will be set-up. However, the overall structures of the slaughterhouse will be sufficiently large to incorporate later the second bay with its slaughter-line.

A plan for a pig slaughterhouse with a capacity between 20 to 25 pigs per day is presented in Annex 8 to this report.

Considering the high investment costs it is however judicious to assess other options and their financial repercussions. The following options are presented and costed out: (1) a slaughterhouse for 20-25 pigs, (2) a two bay slaughterhouse with a total capacity of 50 pigs of which only one slaughter line will be installed (the second line to be installed when additional capacity is needed), (3) a two bay slaughterhouse with a capacity of 50 pigs per day as described in Chapter 4 of this report, (4) a small scale decentralized slaughterhouse for up to 10 pigs (of which 5 need to be built to obtain the same slaughter capacity as foreseen for the central slaughterhouse (Option 3).

2. The construction design presented in this report will allow a local engineering bureau to draw the required construction plan meeting the Ugandan legal requirements which will have to be submitted to the authorities for approval as well as to funding agencies or banks for a loan or any other type of support for investment.

Acknowledgements
I thank the ILRI team (Mr. Peter Lule, Mrs. Kristina Roesel, Mrs. Rachel Miwanda and in particular Dr Danilo Pezo, Project Leader of SPVCD for the support during my stay in Uganda and during the compilation of the report. My thanks and best wishes for her work to Mrs. Mable Kabagabu. I am grateful to Dr Mayega Lawrence, the authorities of Masaka, the executives of the Pig Farmers Cooperatives of Masaka and its Union, Mr. Simon Lubega, Manager of the Wambizzi Cooperative Society slaughterhouse who have contributed with valuable their information to this report.

My special thanks to Civil Engineer Mr Nguyen Manh Thang from the LIFSAP project in Vietnam in charge of the technical supervision of slaughterhouse constructions funded through this project for substantial inputs and comments on the report.

Disclaimer
Some of the pictures hereafter may be irritating in particular for readers not directly engaged in pig slaughtering. As this report is intended as a technical document to be read and analyzed by professionals I felt however that it was necessary to highlight some issues with pictures which speak for itself.

It was not my intention to name and shame people involved in the pig slaughter sector in Uganda and their efforts to provide safe food to their clients because they do their best they can with the means at their hand but they are also committed to improve the process.

As for myself I have enjoyed my pig skewers in Masaka and pig liver in Kampala.
Executive summary

In Uganda, the smallholder pig value chain has been identified by the Livestock and Fish CGIAR program as one of the livestock options where research investments are most likely to make a major difference to the livelihoods and diets of poor people. When assessing the pig value chain from producer to consumer, ILRI had identified the need for proper slaughtering facilities as a core issue to assure hygienic process and facilitate veterinary inspection and disease control.

The Masaka Local Government representing one of the districts with the highest pig population density endowed with an already well structured and organized Union of pig producer societies and with the opportunity of being in reach of the largest market (Kampala) in Uganda has taken the initiative to set up a Public Private Partnership with the Cooperative Union for the construction of a slaughterhouse fulfilling the requirements for hygienic slaughtering while respecting the environment. The contribution of the Masaka local government consists in granting a plot as the construction site for the new slaughterhouse while the Cooperative Union will have to raise the necessary funds.

ILRI through the SPVCD project supports this initiative by hiring a consultant who will assess the feasibility of the intervention based on the design of a facility that responds to the prevalent conditions in the district.

This report is the result of a good familiarity of the consultant with similar smallholder pig value chain promotion in Vietnam during which about 130 pig slaughterhouses of various sizes had been constructed. The mission was undertaken between November 10th and December 10th 2014. From November 10th to 20th the consultant paid a visit to Uganda to discuss with the ILRI SPVCD team and to visit Masaka district to talk with the representatives of the local government and the of the Cooperative Union. He visited the planned construction site and talked with butchers in Masaka. In Kampala the consultant visited the only fully operational and authorized pig slaughterhouse (Wambizzi Cooperative Society Slaughterhouse) and discussed with two private operators intending to invest in the construction of hygienic slaughterhouses.

During the visit and discussion with the Masaka stakeholders the expected outcome of the mission was more detailed. In fact, the stakeholders wanted to combine the slaughterhouse operation with a pig market which should provide pigs as well for traders as pigs for butchers to be slaughtered – hopefully but not necessarily – in the new slaughterhouse. This market should be set up on the same plot as the slaughterhouse. Considering the specific regulations for slaughterhouses and their lairage area (animals which have entered the lairage area are not allowed to leave the zone alive) two activity zones have to be set-up (1) the slaughterhouse (2) the pig market. These two zones will be linked however the management and operations have to be separated.

The design of the slaughterhouse hereafter is the result of these meetings. It is based on the standard operational process for slaughterhouses. It respects the dimension of the available plot which must however be considered as too small to host as well the slaughterhouse and the pig market. If necessary the proposed layout can be used in any other plot which is less restrictive with regard to size, to maintaining an existing building, to anticipated land development costs involving expensive and intensive earthworks (see hereafter) or to the location of waste water units and drinking well which would be ideally from South to North (downstream) starting with the well, the biogas digester and the septic tank at the loading/unloading ramp for the pig market. An alternative plan which is based on the acquisition of additional land on the western side of the plot and the removal of the existing building and water tank (which is in any case too small to be useful for the slaughterhouse) is presented in Chapter 10: Conclusions

The consultant proposes to set up to slaughter pigs simultaneously in two booths (slaughter lines) that will allow the handling of up to 50 pigs per day and if required the clear separation of pigs produced by cooperative members following the instructions of Good Animal Husbandry Practices with regard to the
restriction in the use of antibiotics or growth boosters from pigs produced by other pig holders who will only use the facilities of the slaughterhouse including meat inspection.

The recommended construction is modular allowing to start – if funds are insufficient – with one slaughter-line only. However it must be kept in mind that the slaughter-line only represents about 10% of the investment costs.

The slaughterhouse is based on a steel warehouse construction. This steel frame will provide a maximum of flexibility as no load bearing walls are required to allow the use of local contractors to build the interior using local material (bricks may even be made on site) and unskilled labour from cooperative members to cut down on expenditure. If necessary the lay-out can also be modified.

The equipment for the slaughter-line is basic and should be available within the country or at least within the EAC. It is foreseen to use mainly labour as much as possible e.g. for hoisting the pigs on the gambrels or for moving pigs along the rail. Options for mechanical improvements are made and again will depend on the availability of funds. Starting with the basic set up and adding labour saving equipment will not require large changes in the construction of the slaughter-line.

The largest expenditure factor in the construction and implementation costs will fall on the preparation of the site as intensive earthworks (excavating, leveling, filling, probably also landslide protection will be required), stabilization of the entire inner court of the slaughterhouse through asphalting, and construction of a solid rain water drainage system have to be foreseen. A fresh water system including drilling/digging of a well or borehole well, a water filtering system and water storage in form of a water tower or underground water reservoirs need to be built. As the plot is situated close to the catchment area for the municipality water system an efficient dual waste water treatment system to be installed composed of:

1. Two sedimentation tank systems for the rain water, for the washing area of the delivery vehicles and for the disposal of the content of the disinfection grooves at the gates as this type of waste water containing noxious substances like disinfectants, engine oil and fuel etc. In that way will prevent those contaminants to enter in the biogas system,
2. Anaerobic treatment system for organic waste water from the pig holding pens, the lairage area and the slaughtering operations using a biogas digester and secondary cleaning through fish ponds, lagoons or gravel filters needs to be financed. There may be however opportunities to obtain grants from specialized projects as the Masaka slaughterhouse will have a model character for similar structures which may interest other donors to join the operation.

At a very early stage staffs for administrative and technical operations of the slaughterhouse and of the pig market need to be identified and trained according to their future tasks which include for the managers all aspects of HACCP, QA, GMP and GHP and for the technical staffs considerations on hygienic slaughter operations and on animal welfare which are not part of the traditional slaughtering practices.

A cost estimate for the slaughterhouse is provided. The overall cost of the basic slaughterhouse with is estimated at about US$180,000. Neither included are earthworks for excavation, filling, landslide protection road improvement and well construction nor the additional costs of the pig market. Technical details in particular the quantity of earthwork have to be assessed and detailed by local civil engineers familiar with all technical criteria set up by the competent authorities. In conclusion, it must be said that the available plot is not ideal for the set-up of a slaughterhouse as it will involve heavy costs for the plot development. The Masaka Local Government should be requested to award additional land at the northern side of the plot and to contribute to the costs of preparing the plot for construction works.

It is recommended to assess options like a smaller slaughterhouse or the construction of several small-scale slaughterhouses in the vicinity of the different cooperative societies.
1. Introduction

1.1 Rationale
In Uganda, the smallholder pig value chain has been identified by the Livestock and Fish CGIAR Program as one of the livestock options where research investments are most likely to make a major difference to the livelihoods and diets of poor people. ILRI, with the support of IFAD/EU, has been conducting research on the pig value chain, trying to identify the challenges and opportunities for improving the pig/pork sector in the country. The interventions identified for piloting include the need for proper slaughtering facilities to assure hygienic process and facilitate veterinary inspection and disease control. In all districts where the project operates there is lack of such facilities; therefore the effort to be undertaken through the consultancy will serve as a model for other districts. The Masaka Local Government has taken the initiative to allocate land for a slaughterhouse, and the Smallholder Pig Value Chain Development in Uganda (SPVCD) project decided to support such initiative them by hiring two consultants who will provide a design of a facility that responds to the prevalent conditions in the district and assess the feasibility of the intervention.

1.2 Objective of the mission and expected results
To propose a design for a pig slaughterhouse for pigs that responds to the needs and conditions of Masaka district. However, the design could serve as a model for other districts interested in a similar initiative

1.2.1 Expected results of the mission
- Evaluation of the current slaughtering volumes, practices and facilities used in the pig value chain in Masaka district.
- Assessment of the appropriateness of the land assigned by the local government for building the slaughterhouse, including access to basic services (i.e., water, electricity) needed for the operation of the slaughterhouse, including proper management of wastes. If not adequate, should recommend options for upgrading those services.
- Preparation of at least two design options for the slaughter facility: (a) For 20 pigs, considering that will respond to the current needs, assuming that 75% of the pigs slaughtered in Masaka are taken to the proposed abattoir; and (b) For 50 pigs considering that most pigs produced in Masaka are slaughtered in the district, and the carcasses transported to the Greater Kampala.
- Preparation of a list of equipment required for proper operation and estimated costs (if possible propose potential providers) for the option responding to the current volume of slaughtering.
- Estimation of the costs associated with the construction of the slaughtering facility; information that will be shared with an economist who will analyze the feasibility of the operation.
- Identification of the staff required -including skills and qualifications- for operating the proposed slaughter facility.

1.3 Scope of problems related to pig slaughtering
Pig slaughtering is much easier than cattle or buffalo slaughtering because the carcass is not very voluminous. But it is still heavy enough to require equipment for lifting and suspending. Also, the pig skin typically remains with the pork during processing. With that protective covering intact during the slaughtering, less of the meat surface is exposed and thus not subjected to easy contamination.

However, contamination can occur during the removal of hair from the skin, which is done by scalding the carcass in hot water tanks. Two problems can arise in this process:
- Temperatures of the scalding water, which should be at 60°–62°C, are not sufficiently controlled and usually too hot because the heating is typically done by burning fuel wood beneath the tank. In

\[1\] From FAO Abattoir development
some cases, the water reaches the boiling point and at that temperature the skin is damaged through protein coagulation, which provokes lesions during the subsequent scraping of the knife or machine that could allow micro-organisms to easily intrude through such lesions.

- Many pigs are put into the scalding water, which causes enormous dirt contamination. The necessary periodical refreshing of the scalding water is generally not done.

Pig slaughterhouse operators must be forced to keep the carcasses and the meat off the ground, starting with the scalding process. This can be done in the small- to medium-sized facilities with moderate investment. The solutions proposed in the core report hereafter are absolutely adequate as long as such slaughter operations produce pork for the traditional “wet” (open-air, or fresh) meat markets. With some modifications, they also can also be considered for more demanding chilled-meat production.

1.4 Pig slaughtering in Uganda

Tremendous hygiene problems with heavy meat contamination can occur if the entire pig-slaughter operation is carried out on the ground which is still the case in most pig-butchering facilities visited (see pictures)

1.4.1 Existing slaughterhouses and slaughter practices

1.4.1.1 Wambizzi Cooperative Society Slaughterhouse, Kampala

Wambizzi is the largest and only officially authorized pig slaughterhouse in Kampala, and is operated by the Wambizzi Coop Society Ltd. The slaughterhouse is located in an industrial zone and has a capacity of up to 150 pigs per day. Currently 35 staffs work for the slaughterhouse, and meat inspection is carried out by two veterinarians of the Kampala City Council Authority (KCCA).

The building complex is scattered over the entire grounds. Operations are carried out in different buildings, and carcasses have to be transported by hand from one building to the next. There is some ongoing rehabilitation work, e.g. new holding pens, and the construction of a biogas digester. Further improvements could easily be introduced like composting of solid organic waste.

The slaughter process cannot be regarded as hygienic. Improvements are necessary. However as improvements in food safety will involve costs, which have to be passed on to the clients. Therefore, it is necessary to assess the price elasticity for pork e.g. the willingness of the clients to pay higher prices for better quality before they turn to other animal protein products e.g. chicken or fish.
Pictures from Wambizzi slaughterhouse operations (✓ = correct operation)

Office building

Unloading zone and pens

Bleeding

Scalding

Dehairing table

✓Hoisting to rack
<table>
<thead>
<tr>
<th>Dressed and trimmed carcasses</th>
<th>Meat inspection stamps</th>
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<tr>
<td>Meat is wrapped in bags for transport</td>
<td>Waste water septic tank</td>
</tr>
<tr>
<td>Solid slaughter waste</td>
<td>Untreated waste water flows to a stream</td>
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1.4.1.2 Small scale slaughter slabs operated jointly by several butchers

The pictures are taken from a Masaka slaughter-slab where 6-7 butchers slaughter their pigs (one pig per butcher per day, but sometimes two on weekends and before special feasts).

Each butcher has its own butchery where he (all butcheries visited in Masaka are run by men) sells only meat. Offals (liver, kidneys, lungs, but also head and shanks, intestines) are given to the slaughterers as payment for their work and they sell those to interested customers.

The slaughterers (men and women) provide the cauldron for boiling the water and the fire wood for heating.

The carcass yield (meat only) is about 55-60% of the live weight. The price per kilo of non-graded meat is UGX8000. A pig bought for UGX100000 could be sold for a total of about UGX170000 after slaughtering.
1.4.1.3. Backyard individual slaughter-slabs
The operators of these backyard slaughter-slabs are slaughterers and butchers at the same time. They slaughter either their own pigs or they buy those from other pig producers. They sell in their own butchery (some may have more than one butchery) or in “pork joints” (restaurants selling pig meat together with drinks). In most cases butchers also sell cooked pork for consumption in premises nearby or are taken to home. For that reason pork butcheries are also known as “pork joints”.

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1.4.1.4 Improved small scale slaughterhouses

There exist some private initiatives\(^2\) to improve slaughtering by constructing basic small scale slaughterhouses. An approach like the one visited in Matuga (Wakiso) is praiseworthy and merits receiving ILRI support in terms of technical guidance.

1.4.2 Legal framework, national policies and GoU support

In following paragraphs are extracted some paragraphs of legislation that is relevant to slaughtering of animals. This list is by no means exhaustive:

- Veterinary Surgeons Act 1958
- Public Health Act, The Public Health (Meat) Rules

  “In any city, municipality or town in which a slaughterhouse has been established, no animal shall, except with the permission of the authority, be slaughtered within the boundaries of the city, municipality or town elsewhere than in the slaughterhouse.”

  “Every animal intended for slaughter in a slaughterhouse shall be brought to the slaughterhouse or to a place appointed by the authority not later than twelve hours before the time at which it is intended to be slaughtered Meat inspection and stamping of meat.”

- Code of Meat Inspection Act of 1973

  It was not possible to get a hardcopy of this code or to download a copy from the internet. Any training on meat inspection must however be based on the application of existing laws and not only on international recommendations e.g. FAO Meat Inspection Manual.

The following national policies have an impact on the meat processing sector

- The National Meat policy
- Delivery of Veterinary Services Policy
- Livestock - Uganda Investment Authority – UIA

Specific Sector Incentives

- Inputs used for agricultural purposes are duty and tax free on importation
- Deductible annual allowances of 20% for e.g. immovable buildings, fences,
- dips, drains, water and electricity supply works and other works necessary for the farm
- VAT exempt and/or withholding tax is exempted e.g. importation of machinery

\(^2\) Pig Production and Marketing, Uganda Ltd
General Investment Opportunities

- Construction of modern abattoirs to enable meat production and processing including Abattoirs for pigs

The Ministry of Agriculture, Animal Industry and Fisheries has launched an awareness and sensitization campaign on food safety entitled “Is the meat you are consuming safe”. The poster shows how to avoid bad practices at the different stages of the value chain and recommends good practices. The planned Masaka slaughterhouse will contribute to make meat consumption for consumers safer.
2. Masaka slaughterhouse

2.1 Location

Kijjabwemi Industrial Area, 2km from Maska town, close to the Masaka-Mbarara Highway
Parish Kimanya; Sub-county: Kimanya-Kyabakuza; Masaka Municipality

Map 1: Map of location

2.2 Owner

A Private Public Partnership (PPP) between the Masaka Local Government which will grant the plot to the Masaka Pig Cooperative Union. A progressive ownership transfer from the Masaka Local Government to the Cooperative Union is planned.

2.3 Target slaughter capacity

The Masaka Pig Cooperative Union members and the local government authorities target a capacity of up to 50 pigs per day. Considering the current pig production in the district this target goal may not be reached immediately, therefore the proposed layout of the slaughterhouse focuses rather on a two bays compartment model where each bay is able to handle 25 pigs per day and not on a monorail slaughter line. The second bay can be built later when the slaughterhouse operations exceed the initial capacity of 20 to 25 pigs per day.

Other advantages of the two bay model are described under 3.1 hereafter.
2.4 Slaughterhouse site
The site had been purposely selected by the local government as there are already two tanneries north to the assigned plot and there are no neighbours whose religious feelings may be hurt by intensive pig slaughtering.

The details of the site which had been granted by the district/municipality are shown hereafter

1. Plan 1: Site plan established by the Commission of Surveys and Mapping in the scale of 1: 2.000 showing the location of the assigned plot in relation to neighboring plots and road infrastructure.

2. Plan 2: Plot plan established by the Commission of Surveys and Mapping in the scale of 1 : 500 indicating the north point.

3. Plan 3: Simplified site plan showing all existing (office) and planned buildings (slaughterhouse, water tank, well, pig holding pens, biogas digester, fish pond and/or lagoons, loading/unloading ramp, weighing bridge, pathways for animals from ramp to holding pen and from holding pen to slaughterhouse and the walls on the top and bottom sides of the plot. The north point is shown. The building will be constructed in west-east direction to reduce exposition to sun in order to minimize heating up.

An existing access road is indicated. This road is however located outside the assigned plot and if it cannot be acquired its usufruct should be inked. The more convenient option of acquiring additional land on the northern side of the plot is discussed in Chapter 10: Conclusions

A cross section plan (Plan 4) with approximate gradients indicates the requirements for leveling the plot. This plan needs to be verified by the surveyors of the competent department (Surveys and Mapping) to determine the volume and cost of earthwork (excavation and embankment)

Plan 4: Cross section plan with gradients and earthwork for leveling
Plan 1: Site plan showing also neighbouring plots
Plan 2: Site plan of the plot
Plan 3: Site plan (flat simplified but with correct dimension)

- **MAIN ROAD**: 40 m
- **8 m**
- **14.5 m**
- **11 m**
- **16.5 m**
- **73.5 m**
- **10 m**
- **15 m**
- **30 m**
- **15 m**

**Legend**:
- Asphalt

**Areas**:
- **Car Parking**
- **Access Road to unloading zone outside of plot**
- **Coffee zone**
- **Office**
- **Water tank**
- **Well & Filter**
- **Protective wall against landslides**
- **Exit Gate**
- **GATE TO Compost**
- **GATE TO Septic tank**
- **Water tank**
- **Pig race**
- **Quarantine pen**
- **Delivery**
- **Ramp**
- **Weighing bridge**
- **SWAMP AND RIVER**
- **Biogas**
- **SWAMP**
- **Fish Pond**
- **Asphalt**

2.5 Comments on the appropriateness of site

- The plot could be granted free of charge to the Masaka Pig Cooperative Union.
- The plot is sufficiently far away from residential areas thus avoiding negative impact for population.
- Water is available from a swamp/river at the bottom of the plot. Water from swamp/river is harvested upstream for the communal water network.
- Two tanneries had been implemented downstream from the plot. Power supply is available within a distance of approximately 500 m.

Comments:
- The site chosen by the local government is not ideal for the purpose as it is on a slope which will require a lot of earthwork to level the site.
- The plot is relatively small and the fact that the beneficiaries insist in maintaining a building inside the plot reduces the size for the slaughterhouse construction furthermore.
- The access road is a non-stabilized earth road.
- The plot is too small to build an internal road. The current access to the plot is also not stabilized and in addition outside of the plot. It will be necessary to negotiate the way rights and to stabilize the road.
- Risk of landslides after heavy rains entails the need for protective measures such as ditches or elevated foundation (see 5.3.2.1).
- The recommended composting unit has to be built either on land outside the assigned plot as shown in Plan 3 because the generally accepted rules for the construction of composting units require a distance of + 60 m from any stream, river or lake.

---

3 The plot had been used previously as training centers with on brick building, a small water-tower, a biogas tank and a reservoir which used water from the river
3. Operation of planned slaughterhouse

The ideal abattoir operation uses the line-slaughter system. “Line slaughter” entails hoisting up the carcass at an early stage, preferably beginning with the bleeding. All subsequent slaughtering and dressing procedures are carried out with the carcass suspended on and moving along an overhead rail (or line). Line slaughter is suitable for pigs but also for bovines and small ruminants. However, the slaughterhouse line requires more investments.

An alternative is the bay or booth slaughter system in which batches of animals can be slaughtered simultaneously. A team of slaughter-men attends each slaughtering bay. The animals in a batch are kept in pens linked to the bay and are taken one by one to be slaughtered in the bay and hoisted to relatively short rails for further processing after stunning, scalding, and dehairing.

Using a semi-line approach in which the necessary equipment, such as hoists (there is no need using electro mechanical hoists because manual lifting equipment can achieve the same result). The inclusion of cutting tables allows hygienic slaughtering and dressing at low costs.

3.1 Rationale for the choice of a semi-line bay (booth) slaughterhouse

3.1.1 Investment costs
Bay slaughterhouses are cheaper to construct than monorail line slaughterhouses.

3.1.2 Social considerations
The slaughterhouse operator can rent out the bay – against a service fee for using the facility - to individuals or groups which use their own team of slaughter-men under the surveillance of the foreman (supervisor) of the bay. The use of the existing slaughter men will avoid social hardship considering that each slaughter man is the source of income for a family and removing slaughter activities from the village level to a central slaughterhouse may entail the loss of income for these women and young men currently carrying out slaughter activities.

However the slaughter men need to be trained in slaughter operations with an improved bay slaughtering system to avoid congested situations due to staff not knowing exactly their role and tasks.

3.1.3 Quality considerations
The two bay (compartment) set-up will allow the slaughterhouse to provide services to pig producers/traders who are not members of the Cooperative Union; then pigs belonging to cooperative members can use one of the two bays and non-members who use the slaughterhouse paying a fee for the use of the infrastructure and meat inspection will be directed to the second bay.

Branding: If the Cooperative Union considers to improve the quality of its pig keeping by introducing for example Good Animal Husbandry Practices (GAHP) their animals can be “branded” by using in addition to the meat inspection stamps specific stamps indicating the origin from a GAHP production unit which can be a mean of getting better prices from consumers willing to pay a premium price for higher quality and safer meat.
3.2 Flowchart of GHP/GMP slaughter operations
A diagram indicating the flowchart within a slaughterhouse, the main 4 zones (lairage, dirty zone, clean zone, cold-room (chilling) and complementary activities (*ante- and post-mortem* inspection, washing of carcass) is presented hereafter (Diagram 1)

Diagram 1: Flowchart of slaughter operations in pig abattoirs

<table>
<thead>
<tr>
<th>FLOWCHART OF GOOD MANUFACTURING PRACTICES FOR PIG ABATOIRS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AREA</strong></td>
</tr>
<tr>
<td><strong>LAIRAGE</strong></td>
</tr>
<tr>
<td>Receiving of pigs</td>
</tr>
<tr>
<td>Stunning</td>
</tr>
<tr>
<td>Bleeding</td>
</tr>
<tr>
<td>Scalding-dehairing - hoof removing</td>
</tr>
<tr>
<td>Singeing</td>
</tr>
<tr>
<td>Head removing</td>
</tr>
<tr>
<td>Shank cutting</td>
</tr>
<tr>
<td>Evisceration</td>
</tr>
<tr>
<td>Carcass splitting</td>
</tr>
<tr>
<td>Weighing</td>
</tr>
<tr>
<td><strong>Chilling room</strong></td>
</tr>
</tbody>
</table>

Note: Singeing and chilling steps can be omitted where necessary or appropriate
3.3 Operation line of slaughtering

The slaughter-line presented in Diagram 2 below takes into account that once the hair is removed from the pig and the pig washed, there should be no further contact between the skin and the floor. The carcass is hoisted on the gambrel. This step also separates the dirty zone of the slaughterhouse from the clean zone and consequently a disinfection groove will be built at this level (see Figure 11 perspective plan hereafter).

Diagram 2: Slaughter line for pigs

<table>
<thead>
<tr>
<th>Dirty area</th>
<th>Clean area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stunning</td>
<td>Hoisting to rail</td>
</tr>
<tr>
<td>Bleeding</td>
<td>Evisceration</td>
</tr>
<tr>
<td>Dragging to vat</td>
<td>Splitting</td>
</tr>
<tr>
<td>Scalding vat</td>
<td>Gambrel</td>
</tr>
<tr>
<td>Scraping</td>
<td>Meat inspection</td>
</tr>
<tr>
<td>Removing of and head</td>
<td></td>
</tr>
</tbody>
</table>

The waste water is either:

- Completely separated with one circuit for the dirty zone including the pig pen and even the delivery zone with car washing and the lairage area and one circuit for the clean zone (evisceration, splitting, meat inspection, cutting, delivery).
- Waste water flows from the clean zone towards the dirty zone.

A short description of the different steps is provided hereafter for those activities which will be new in the planned slaughterhouse.

3.3.1 Reception and ante-mortem inspection

Pigs are unloaded and transferred into the lairage area where they will remain at least for 12 hours before being slaughtered. Water and some feed will be provided.

The ante-mortem inspection is carried out in the lairage area.

Pigs which show signs of disease are removed into a quarantine pen for further observation. If the health problems are related to transport stress (in particular in great heat or over long distances) they may recover.

3.3.2 Stunning

For reason of humane slaughtering and animal welfare pigs are stunned prior to bleeding. Typical stunning methods are electric stunning with the help of specific pliers or the use of a bolt stunner.

Electric stunning pliers can be manufactured locally (technical details are provided in the slaughter line equipment listed hereafter).

---

4 Modified from FAO publication “Abattoir development”
The purchase price of captive bolt stunners is reasonable, but importing a continuous supply of cartridges can be difficult for individual abattoirs in countries with air freight or firearm restrictions.

3.3.3 Bleeding
If blood is collected for further processing a pig restrainer must be used, otherwise the blood is channeled into the sewage system. (See figure 9 in Annex 5)

3.3.4 Scalding
Scalding should be done using hot water (at 60 to 62°C). Colder water will not soften the hairs sufficiently, and hotter water will burn the skin. Hot water can be produced either by using a cauldron or in a central hot water station.

Scalding can be done by either pouring hot water onto the carcass or submerging it in a container (the scalding vat) filled with hot water. In the latter case, it is necessary to change the water frequently as it will get soiled. However, it may be difficult to load and unload the carcass in the scalding vat unless a hoist is used for this purpose.

3.3.5 Dehairing and hoof removing
Dehairing is done with the help of razor blades but better results are obtained when using a bell scraper.

Pictures: Hog bell scrapers

http://www.onesharpstore.com/catalog/item/1551715/6002587.htm
An alternative which is still commonly used in rural areas of Europe is the use of rosin (colophony)\(^5\). The skin of the slaughtered animals is painted with this rosin before being scalded with hot water. This permits removing the bristles completely in a very fast manner.

3.3.6 Evisceration \(\text{(including head removing)}\)
Use of knives

3.3.7 Carcass splitting
Use of axes/choppers

3.3.8 Post mortem inspection and stamping

3.3.9 Cutting
Half carcasses can be cut into 2 quarters. The carcass can be trimmed i.e. removal of fat

3.3.10 Weighing

3.3.11 Delivery

3.4 Optional equipment

3.4.1 Dehairing machine
Annex 5 shows a mechanical dehairing machine as used in China. The company clearly states that this machine is not accepted in Europe or the USA but widely used in China. However, the capacity of the machine is much larger than needed (100 to 200 pigs per hour)

3.4.2 Solar water heater
Solar heaters do not reach the necessary temperature require for scalding. However, as hot water is required for cleaning then it can be used to supplement the hot water requirements of the slaughterhouse.

3.5 Required equipment and approximate costs
The equipment/material for each of the two slaughter lines is shown in the following table. The prices are indicative as they depend on the necessity to import material; however, depending on the capacity of the local industry, those could be manufactured locally, and the cost will be very much dependent on the cost of raw materials e.g. for stainless steel tubes.

\(^5\) http://dir.indiamart.com/impcat/gum-rosin.html
Table 1: Equipment, quantity and price for each slaughter line

<table>
<thead>
<tr>
<th>Designation</th>
<th>Qty</th>
<th>Price US$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recommended material</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical tongs can be produced locally with the following specifications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Capacity of transformer: 0.5KVA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Stunning voltage: 70 ~ 90V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Stunning current: 1.0 ~ 1.2A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Input voltage: 220V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Stunning time: 1 ~ 5 seconds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Output voltage: 0 ~ 250V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Sizes range is about: 220X130X340mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annex : Description of slaughter equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cauldron cast iron casing</td>
<td>1</td>
<td>500</td>
</tr>
<tr>
<td>Scraping table (stainless steel, locally made) Stain less steel (INOX), 150</td>
<td>1</td>
<td>1,500</td>
</tr>
<tr>
<td>cm L x 80 cm W, 80 cm H, stainless steel squared frame 2 cm x 2 cm, legs</td>
<td>2</td>
<td>1,500</td>
</tr>
<tr>
<td>4 x 4 cm, 2 horizontal crossbeams and 8 vertical cross beams (square stainless</td>
<td>1</td>
<td>1,500</td>
</tr>
<tr>
<td>steel 2 cm x 2 cm), Annex 5: Description of slaughter equipment)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hog scraping bells</td>
<td>2</td>
<td>200</td>
</tr>
<tr>
<td>Gambrel (rails) system (galvanized, locally made) app. 5-6 m in length,</td>
<td>1</td>
<td>3,000</td>
</tr>
<tr>
<td>Galvanized Steel, tubes diameter &lt;5 cm (see Annex 5: Description of slaughter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>equipment)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hooks and gambrel (stainless/galvanized, locally made) Annex : Description</td>
<td>100</td>
<td>3,000</td>
</tr>
<tr>
<td>of slaughter equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual hoist, locally made using a manual winch and pulley</td>
<td>1</td>
<td>200</td>
</tr>
<tr>
<td>Cutting table galvanized steel (locally made) 150 cm L x 80 cm W, 80 cm</td>
<td>1</td>
<td>1,500</td>
</tr>
<tr>
<td>H, stainless steel squared frame 2 cm x 2 cm, legs 4 x 4 cm, 2 horizontal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>crossbeams and 8 vertical cross beams (square stainless steel 2 cm x 2 cm),</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annex 5: Description of slaughter equipment)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scale</td>
<td>1</td>
<td>500</td>
</tr>
<tr>
<td>Set of butcher knives, axes, choppers, imported Annex 5 : Description of</td>
<td>1</td>
<td>5,000</td>
</tr>
<tr>
<td>slaughter equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disinfection container for knives after use</td>
<td>1</td>
<td>1,000</td>
</tr>
<tr>
<td>Container to collect seized animal by products (aluminum, water tight)</td>
<td>1</td>
<td>1,000</td>
</tr>
<tr>
<td>Pressure cleaner</td>
<td>1</td>
<td>500</td>
</tr>
<tr>
<td><strong>TOTAL BASIC EQUIPMENT</strong></td>
<td>14</td>
<td>300</td>
</tr>
<tr>
<td><strong>Options and alternatives</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Captive bolt stunner as an alternative if electricity problems exist e.g.</td>
<td>1</td>
<td>400</td>
</tr>
<tr>
<td>frequent power failures Annex 5: Description of slaughter equipment)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scalding vat (stainless steel, locally made) Annex 5: Description of</td>
<td>1</td>
<td>2,000</td>
</tr>
<tr>
<td>slaughter equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colophony for dehairing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical dehairing machine, Annex 5: Description of slaughter equipment)</td>
<td>1</td>
<td>5,000</td>
</tr>
<tr>
<td>including transport from China to site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electro mechanical hoist with winch, 200 kg hoisting load</td>
<td>1</td>
<td>1,000</td>
</tr>
<tr>
<td>Restrainer if blood should be collected Annex 5 : Description of slaughter</td>
<td>1</td>
<td>500</td>
</tr>
<tr>
<td>equipment)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viscera cart Annex 5 : Description of slaughter equipment)</td>
<td>1</td>
<td>1,000</td>
</tr>
<tr>
<td>Electric splitting saw</td>
<td>1</td>
<td>5,000</td>
</tr>
<tr>
<td>Solar water heater</td>
<td>1</td>
<td>2,000</td>
</tr>
</tbody>
</table>
4. Layout of the slaughterhouse

The slaughterhouse design is based on the criteria of use e.g. the number of animals to be slaughtered, the available land.

In the case of the Masaka slaughterhouse a rectangular shape had been proposed because it fits into the available plot (Plan 3).

The main structure will be a steel construction as it is used nowadays for warehouses or industrial manufacturing sites. Such steel constructions can be quickly set up as they are pre-fabricated according to the client’s specification. The metal construction composed only of the metal frame and the roofing (transparent roof sheets may be an option to save on lighting costs) allows a flexible adjustment of the different compartments (rooms) within the slaughterhouse. There will be no load bearing walls which again allows a flexible re-arrangement of rooms.

The options hereafter show how exterior walls can be built using either bricks or metal sheets (see also the picture below which uses the combination of bricks and metal sheets). The finishing work can then be carried out with local contractors using the labour force of the Cooperative Union members.

Figure 1: Steel construction
Figure 2: Floor-plan of the metal warehouse
Figure 3: Roofing of planned metal construction
Figure 4: Eastern façade of slaughterhouse (meat delivery)

Figure 5: Western façade of slaughterhouse (pig reception)
Figure 6: Option for western facade using bricks and metal sheets

Figure 7: Cross section of eastern façade using bricks and metal sheets
Figure 8: Southern lateral façade (pig reception and meat delivery) using bricks and metal sheets
Figure 9: Northern lateral facade
Figure 10: Floor plan of slaughterhouse with a capacity of 50 pigs/day
Figure 11: Perspective floor-plan of rectangular slaughterhouse for slaughtering 50 pigs per day
Figure 12: Water supply system
Figure 13: Drainage system
5. Construction work

5.1 General slaughterhouse construction standards

Materials employed to construct the plant should be strong, durable, and promote maintenance inside and out. Masonry and steel construction have proven to be the most acceptable.

Floor, wall, and ceiling material, as well as coatings and joint sealant must be of an approved type. Generally, they must form a durable, smooth, impervious surface, which is readily cleanable.

- **Floors**
  All workroom floors must be coved and constructed of hard impervious material such as: dense acid resisting, non-dusting, and waterproof concrete, and graded 1-2 cm/m to the drains, the floor should be sloped down gradually towards the waste water collector of drainage, no hollow point to cause stagnant. The corners between walls and floors should be rounded.

- **Drains**
  An adequate number of floor drains must be provided in all areas of the establishment. The number and location of drains is determined by the design and volume of the operations. All drain lines must be sloped, deep seal-trapped, properly vented to the outside air, and equipped with effective rodent screens. Floors must slope uniformly to drain inlets, with no low spots that could collect liquids. In critical areas, overhead drain lines should be avoided.

As a general rule, one drain inlet, 30 cm x 30 cm or equivalent, should be provided for each 40 m$^2$ of floor space. The number of drain inlets and their size should be increased in areas of high water usage to provide for constant removal of fluid wastes. Direct drainage must be provided for equipment discharging large volumes of water in order to prevent flooding of surrounding areas.

Where several 10-cm drainage lines discharge into one trunk line, the trunk line must be proportionately larger in order to effectively handle the fluids discharged into it. The minimum longitudinal slope of the sewer is directly related to the size of the pipes (which is related to the amount of water to be handled with a safety margin for heavy rainfalls), to the required velocity to evacuate the waste water. As a rule of thumb sewers should be designed with a minimum slope of 0.4% or greater.\(^6\)

- **Walls and Ceilings**
  Walls and ceilings must be smooth, level, hard and consist of impervious material such as acceptable prefabricated panels, and be free from pitting, indentations, cracks, crevices and ledges. All corners and junctions of walls and floors must be coved in the kill floor, coolers, condemned and processing areas, and other areas subject to frequent cleaning and moisture. Ceilings should be at least 3.3 m in height. Ceilings of rooms intended for livestock receiving, slaughtering and dressing should be at least 4.8 m in height. All mortar joints must be smooth and flush. Scoring cement plaster walls should be discouraged. To promote light reflection and sanitation, wall and ceiling surfaces should be white or light-colored.

Whenever practical, materials that do not require painting should be used. Materials that are absorbent and difficult to keep clean must not be used. Examples of unacceptable materials include wood, wood products, materials which absorb and retain moisture, or impervious porosity, those which readily absorb or retain fluids, and materials which are readily contaminated by organic materials.

plasterboard and porous acoustic-type boards. Walls should be provided with suitable sanitary-type bumpers or sloped curbs to protect them from damage by hand trucks or lifters.

Windowsills should be at least 1 m from the floor to avoid damage on impact from chill tanks, lifters and hand trucks.

- **Doorways and Doors**
  Doorways should be a minimum of 1.5 m wide so that products transferred on rails, hand trucks or lifters do not come in contact with them. Doors and door jambs should be made of rust-resistant material and be self-closing. The juncture between the wall and the door jamb must be sealed with a flexible sealing compound. All doors leading outside must be self-closing.

- **Lighting**
  All areas of the plant must be adequately lighted, and generally provided with a minimum intensity of not less than 200 lux. Where special illumination is required for the proper conduct of work by plant employees and inspectors, an illumination intensity of at least 500 lux must be in place. To prevent glare and provide the maximum illumination, special attention must be paid to the amount and direction of lighting in inspection areas.

Artificial light sources must not impart illumination that distorts the normal appearance of meat. Only normal non-colour corrected lights are acceptable. Meat products must be protected from contamination resulting from the breakage or shattering of light sources or fixtures.

- **Water Supply**
  Water supply for slaughterhouses must meet the quantity demand in term of technology as well as the scale of the slaughter. Water quality must comply with existing national technical regulations on drinking water quality.

  Firefighting water supply system should be in compliance local regulations as well as complying with the provisions of the local Fire Authority.

- **Hand Washing Facilities, Sanitizers and Hose Connections**
  Hot and cold water hand washing facilities (remote control operated is recommended) must be readily accessible to all processing and slaughtering areas. These facilities must be serviced with dispensable soap and paper towels.

  Rust-resistant metal sanitizers of appropriate size and number must be supplied, so that knives and saws can be sanitized. Sanitizers should be able to maintain a temperature of 82°C, be equipped with an overflow, and, except in the kill floor area, connected to a drain.

  To facilitate room and equipment clean-up, an adequate number of hose connections must be provided throughout the slaughterhouse. Hot water, of at least 82°C must be available at the point of discharge to sanitize equipment during slaughter, evisceration, and processing operations. For general clean-up operations, water may be kept at a lower temperature, provided satisfactory cleaning and sanitizing agents are utilized. The use of long hoses entailing a decrease of the water temperature of hot water should be avoided. Suitable racks or reels for hose storage should be in place.
5.2. Detailed construction design

The following documents need to be prepared by a civil engineer to be submitted to the authorities to receive the construction permit.

(a) General floor plans:
- Drawings of current floor or drawing of overall land
- Drawings of the master plan
- Drawings of the work locations
- Drawings of overall technical infrastructure such as water supply, sewerage, electricity, garden, internal roads. In that, showing the present boundary of the construction site and location of the slaughterhouse compared to other structures, internal roads and entrance roads to all facilities for operating and management, entrance to parking, drainage system, surface materials (such as gravel, asphalt, concrete yard, walkways, yards for gathering, etc.), railroads, sewer, water lines and manholes, power line, etc. In drawings, ratio should be written and for the ground drawings, wind direction (wind flower) should be specified.

(b) A floor plan of each level of the plant, showing the purpose for which each room is to be used, location of walls, partitions, windows, doors, posts, conveyor rails and all equipment (including draw-off fans, refrigeration units, hose bibs, sanitizers, hand-wash stations, water pump, boiler, boiling water tank, etc.).

(c) The exterior elevations of the building, showing doors, windows, and platforms.

(d) A cross section of the plant where is necessary showing heights of ceiling, floor, equipment inside and device for animal gambrelling and other details, etc.

(e) A roof plan showing skylights, vents, drainage and other pertinent information;

(f) A schedule of room "finishes" must be on or attached to the plans, including a schedule of door sizes, construction and type of door frame; lighting intensity for each room;

(g) The design and detailed drawings of all work items in the project.

(h) The technical infrastructure drawings related to: water supply, sewerage, electricity, roads, levelling.

(i) Water supply drawing:
- Drawings of the overall water supply system, showing entire pipelines and related works/devices. Showing size, flows of water supply pipes. Diameter of pipes should be based on using demand as well as the operational pressure of the equipment.
- Drawings of water supply of works: water supply plans of the slaughterhouse, WC.
- Drawings of works for keeping and treatment of water: wells, reservoirs, treatment works, pumping stations, water stations.
- The space schematic drawing of water supply systems: showing space diagram of the entire water supply system in the slaughterhouse, together with the heights.
- Other necessary detailed drawings.
- Statistic of additional materials needed for the system.

(j) Drainage Drawings:
- Drawings of the overall storm water and garden drainage system.
- Drawings of the overall wastewater drainage: which shows the location and size of floor drains, location and size of drains directly arranged for equipment using big volume of water, drainage ditches, sloping down the floor towards the drains.
- Drawings of waste water treatment works: details of works in the wastewater treatment area. Showing pipes, height, height of water level, water flow direction, the equipment to be installed, etc.
- Vertical drawings of drain lines/storm water drains, sewage system.
- Other necessary detailed drawings.
- Statistics of additional materials needed for the system.

(k) Drawing of power supply:
- Drawings of the overall electricity supply: showing power cables from the connection position to all the load (expressed in suitable scale), information on cables.
- The drawing of power supply for external lighting
- The power supply diagram (one cable).
- The drawings of power supply (lighting and power) inside the building.
- Other necessary detailed drawings.
- Statistics of other materials needed for the system.

(l) Drawings of roads:
- The drawings of overall garden, internal roads
- The drawings showing the detailed structure of the works.
- Other necessary detailed drawings.
- Statistics of additional materials needed for the system.

(m) The structure drawings of all building works in the project: foundation, walls, ceilings, floors, rafters, columns, fully reflect the materials used, specifications, details of structure, cross sections needed, steel statistics with instructions provided.

(n) Drawings showing connection points of the technical infrastructure with existing systems together with memorandums to the management body of the locality.

(o) Drawings of the existing buildings.

(p) Drawings of connection with the existing building.

(q) Where the plans refer to significant alterations or changes within an existing plant, the existing layout and construction should be attached to explain the nature, extent, and effect of proposed changes, and

(r) Other necessary drawings to understand clearly the work (if necessary).

5.3 Site works

5.3.1 Site access
The excavation and soil stabilization requires the use of heavy machines (graders, tractors, etc.). Steel or metal buildings are very heavy when shipped and packaged. The truck carrying the materials must have an unobstructed access to the site. Checking for overhead wires is required. If the access road is not finished yet, be sure the truck will not be mired in mud, as it will be carrying an extremely heavy load.

There is need for an adequate amount of room to work in. The truck needs to be off-loaded; a place to put the materials while building is required.

Utilities like electricity and water should be in place prior to starting with the construction. The slaughterhouse should be connected to a transformer of about 20 kW.

5.3.2 Earthwork
Earthwork is required for the preparation of the ground (leveling, excavation, shaping of ground) to suit footings and floor slab layout. Earthwork is also required to dig the biogas plant, the fish-ponds/and or lagoon or a gravel filter, earth tanks as water reservoir (alternative or complementary to the water tower).

5.3.2.1 Landslide prevention
Some preventive measures may be necessary to avoid landslides. The advice of an engineering geologist or a geotechnical engineer should be sought to evaluate the potential for landslides and other geology-related problems.

It will be necessary to ensure surface drainage through ditches along the main road,
5.3.3 Preparation for plumbing, electricity and sewer system

Once the earthwork has been completed, the plumbing and electrical contractors have to lay out their lines prior to the foundation being poured.

5.3.4 Foundation

The foundation has to be about 25% larger than the actual size of the building (for the planned 15 x 30 m construction the foundation should be about 20 to 35 m).

Steel buildings only require minimal excavation. It can be done with hand tools such as a pickaxe, shovel and steel rake. A 6 – 10 cm deep base for a poured concrete foundation should suffice. The thickness of the floor determines its ability to hold heavy loads. Many jurisdictions have however specific requirements regarding floor thickness and load-bearing ability and must be respected.

Before the concrete can be poured, the foundation wall must be placed. Foundation walls are used to hold the concrete together while it dries and to dictate its shape. Foundation walls serve as supports for other walls and columns. Steel bars or iron mesh wire will reinforce the foundation.

When pouring floor surfaces, the concrete must be screeded before it is finished. Screeding is the method of leveling a floor by pushing away excess concrete and using a template to push concrete into lower or under filled areas.

After the first 72-hours, the concrete should be strong enough to allow further construction on the building.

5.3.5 Assembling of the steel building

This work should be carried out by the contractor from whom the steel construction had been ordered.

5.3.6 Masonry work, plumbing, electricity, sewage

Walls, windows, and doors can be built by local contractors. The Cooperative Union members may provide labour to reduce construction costs e.g. for the on-site production of bricks.

Two separate sewage systems are required:

- One for the rain water, the washing area of the trucks. And the wheel splashes (see below) at the entry and exit of the slaughterhouse. This water has to be treated through a sedimentation tank as the residues of oil, grease and disinfectants will be noxious for the biogas operations.
An anaerobic waste water treatment system for the pig pens, and the slaughterhouse operations composed on a biogas digester, and secondary treatment facilities such as fish ponds, lagoons, gravel filters or a trickling irrigation system.

5.3.7 The inner court of the slaughterhouse
The entire court of the slaughterhouse has to be asphalted (see Plan 3)

5.4 Other elements of the slaughterhouse

5.4.1 Walls, gates, and wheel splashes

5.4.1.1 Walls
Walls should surround the entire slaughterhouse. As construction is labour-intensive, it is proposed that members of the Cooperative Union provide labour under the guidance of a mason.

5.4.1.2 Gates
Iron gates which can be closed after working hours are recommended.

5.4.1.3 Wheel splashes
The purpose of a wheel splash is to disinfect the wheels of vehicles moving into the farm area, thereby limiting the spread of infectious and parasite diseases. Wheel splashes are relatively expensive to construct and maintain and, to be effective, they must be kept filled at all times with a disinfectant. A wheel splash is a shallow basin made of waterproof concrete with 2-metre long entrance and exit ramps sloping 1 in 8. The center section of the splash containing the disinfectant should be long enough to allow the largest wheel of a truck or tractor to make at least one full turn before reaching the other ramp (4–6 meters).

5.4.2 Well (borehole well) and water filtering

5.4.2.1 Well
The ground water table close to the swamp river should provide an opportunity to dig a well. For better water quality a borehole well might however be considered which catches the water below the river bed. The slaughterhouse will need about 20 to 25 m³ for the planned slaughter of 50 pigs. The well, filter and water storage must meet these requirements.

5.4.2.2 Water treatment

Water filter
The basic principle of the process is quite simple. Potentially contaminated freshwater flows through a layer of sand, where it not only gets physically filtered but biologically treated. Hereby, both sediments and pathogens are removed. This process is built on the ability of organisms to remove pathogens. Although the physical removal of sediments is an important part of the purification process, the relevant aspect is the biological filtration. The top layers of the sand become biologically active by the establishment of a microbial community on the top layer of the sand substrate, also referred to as ‘schmutzdecke’. These microbes usually come from the source water and establish a community within few days. The fine sand and slow filtration rate facilitate the establishment of this microbial community. Chlorination is possible in the second chamber (weir chamber which has a similar function a sedimentation tank. From there the

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water flows into a clean water reservoir). With the help of a booster pump it can then be pressed into the water system of the slaughterhouse).

**Figure 15: Water filter**

![Water filter diagram](image)

Instead of a brick construction the water filter can also be made of stainless steel of 2.5 mm thickness. Filtration speed 4 m / h.

- Filtration: two layers of filter material is sand and activated carbon. Thickness of quartz sand for removal of iron, manganese black sand to remove a minimum of 600 mm. Minimum thickness of activated carbon 400 mm.

  - **Pump**
  
  To pump water from well (borehole) into the filter. The type of pump will depend on the depth of the well:

  - Centrifugal pumps are low cost but limited to wells not deeper than 4-6 m.
  - Deep-well jet pumps are appropriate for wells in which the water level drops to 30 meters.
  - Submersible pumps are available in a range of sizes and are an efficient, and trouble-free design for medium-sized installations

**5.4.3 Water tank on tower, replenishing pump, chlorination unit, booster pump**

**5.4.3.1 Water tower**

Water requirement for pig slaughterhouses is estimated by FAO at 450 liters per slaughtered pig. The planned slaughterhouse for 50 pigs per day will require about 22.5 m³ of water per day. A large water storage container (10 m³ tank i.e. 2.5 * 2.5 * 1.6) must be constructed to hold part of the water supply at a height sufficient to pressurize a water distribution system.

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8 Pressurization occurs through the elevation of water; for every 10.20 cm (4.016 in) of elevation, it produces 1 kilopascal (0.145 psi) of pressure. 30 m (98.43 ft) of elevation produces roughly 300 kPa (43.511 psi), which is enough pressure to operate and provide for most domestic water pressure and distribution system requirements.
5.4.3.2 Pump
To pump well/reservoir water into the water tank.
Cast iron casing with the following minimum specifications:
  Flow rate 1.5 m³/h, head H = 12m, 1450 r/min.
  Type of pumps: centrifugal horizontal axis
  Scallop: 220V, 1 phase

5.4.3.3 Continuous chlorination of water inside the water tank
Water to be chlorinated has to be filtered before applying the treatment. Chlorine is readily obtainable as sodium hypochlorite commonly known as household bleach. This product contains 5 percent available chlorine. Chlorine is also available as calcium hypochlorite, which is sold in the form of dry pellets with up to 70% chlorine content.

A basket containing chlorine pellets could be placed near the inflow of the tank so that the incoming water flows over the tablets. This is the best way of to ensure good contact between the water and the chlorine.

A second solution is to circulate a small amount of water through a container of tablets before re-entering the water supply system. The amount of water permitted to circulate through the tablet container determines the chlorine concentration and can be adjusted by the restrictor valve.

Figure 16: Water chlorination system
5.4.3.4 Booster Pump

The planned 8 m water tower with a 10m³ tank (e.g. 2.5 * 2.5 * 1.6) will however only produce 11.4 psi which is insufficient for the slaughter operations. Therefore a booster pump will be needed (220V, 3phase) able to boost the pressure to 43 psi (and even above)

5.4.3.5 Rain water collection from slaughterhouse roof (optional)
Earth tank with runoff. There are two options

- Similar construction as biogas digester using concrete bricks, app. 10000 liters.
- Cylindrical reservoir using prefabricates concrete rings. They are straightforward to install. Less expensive if cast on site. Capacity between 2000 and 3000litres. Option: installation of several reservoirs.
- Composite /plastic tanks. Those are available in the local market, however several tanks need to be installed due to their limited capacity.

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9 Booster pump: https://www.plumbingsupply.com/boosterpumps.html
5.4.4 Access road, car parking, delivery zone

About 60 m of road to access the loading/unloading ramp need to be stabilized. The requirement is an all-weather, all-year road access to the ramp and the pig pens that will allow vehicles to turn near the ramp (light trucks require about 12 m of space for turning) and to mount back to the main road even during heavy rain falls.

5.4.4.1 Upgrading of road using existing soil and installing drainage

The road leading to the ramp will be constructed by digging out soil from the sides and throwing it onto the road until the cross-section illustrated in figure below is obtained. The 30 cm difference in level between the road surface and the bottom of the side drains, combined with the camber of the road surface, will ensure a much drier roadway with a higher carrying capacity than a simple earth track. Properly installed drainage and road maintenance go hand in hand to ensure the durability and carrying capacity of an earth road.

Figure 17: Cross section of an upgraded earth road

5.4.4.2 Construction of gravel road

Gravel is often considered as a cheap option if:

- sources of gravel are nearby (as transport is expensive),
- road gradients are less than about 6%, (gravel surface can be quickly washed away),
- rainfall is low or moderate (less than 2,000 mm/year),
- traffic is relatively low (usually less than about 100 motor vehicles/day),
- finance and resources are available for periodic re-gravelling (maintenance is expensive, especially for periodic re-gravelling, which is typically required at three to five year intervals),

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• dry season dust generation is not severe (dry season dust loss leads to the surface disintegrating, and again washed away during the rainy season, particularly on steep sections).

5.4.4.3 Car parking and delivery zone
The car parking zone bordering the main road should be graded and stabilised using asphalt. The delivery zone will also be stabilised using gravel.

5.4.5 Loading/unloading ramp
A loading ramp is necessary for loading/unloading of pigs into/from trucks. The ramp floor must have cross-battens every 20 cm to prevent slipping.

Figure 18: Loading ramp

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Figure 19: Loading ramp dimensions
5.4.6 Pig holding pens with pig race and weighing bridge

5.4.6.1 Holding Pen and quarantine stable
For the construction of a pig house it is advisable to use concrete for the floor or to compact the floor hard.

Figure 20: Pig holding pen

5.4.6.2 Pig scale
Two options:
- Mechanical scale with restraining cage (see picture),
- Electronic pig scales.
- Weighing bars to be integrated into the pig race, electronic registration of weight.
Electronic scales and weighing bars require that all cables etc. are protected against water, and rodents which may nibble on the wires. Mechanical scales are well known for their robustness. The construction of a roof to prevent against rain is judicious. It is recommended to use mechanical scales with a capacity up to 300 kg.

5.4.7 Chilling/cold store

The object of refrigeration is to retard bacterial growth and prolong the shelf-life. Chilling meat post-mortem from 40°C down to 0°C and keeping it cold will give a shelf-life of up to three weeks. Carcasses must be placed in the cooler immediately after weighing. They must hang on rails and never touch the floor. Carcasses should not be cut into smaller portions at this stage.

However, failure to bring down the internal temperature quickly will result in rapid multiplication of bacteria deep in the meat resulting in off-odours and bone-taint.

The cooler should not be overloaded beyond the maximum load specified by the manufacturers and spaces should be left between carcasses for the cold air to circulate. Otherwise cooling will be inefficient and the carcass surface will remain wet, favouring rapid bacterial growth forming slime.

Once filled, a cooler should be closed and the door opened as little as possible to avoid sudden rises in temperature. When emptied, it should be thoroughly washed before refilling. Chilled meat must be kept cold until it is sold or cooked. If the cold chain is broken, condensation forms and microbes grow rapidly.

The use of a cold room (chillers) entails the use of an insulated, refrigerated van. Meat must hang on rails. Not insulated vans and open trucks should not be regarded as suitable transport for chilled meat, particularly in hot climates.

Low cost options replacing a fixed chilling room are refrigerated container or trucks. Second hand containers and trucks are available online at variable prices.

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6. Staff

6.1 Number and tasks
The ideas on staffing are minimum requirements; however, there is room for more staff on the upwardly open employment scale.

6.1.1 Slaughterhouse
1. Director: S/he should have a solid managerial educational background and practical experience in managing complex production units
2. Technical director. Civil engineer, livestock /veterinary background with experience in agribusiness, s/he should be familiar with meat inspection, HACCP, QA, procedures
3. Accountant
4. Dispatcher in charge of controlling the outgoing meat (conformity with invoices, quantity, etc.).
5. Slaughter-men, at least 6 people per line under the supervision of a foreman, trained in slaughter operations
5. Auxiliary staff
5.1. Cleaners
5.2 Watchmen (there are two gates, one for vehicles and people, one for the animals entering from the holding pen)
5.3 Maintenance with experience in plumbing, electricity, sewage and water supply
6. Meat inspector (2)
Meat inspectors are not staff of the slaughterhouse but responsible to the veterinary services. Some countries use private veterinarians as meat inspectors under the sanitary mandate.

Meat inspection fees have to be paid by the owner of the animal to the competent veterinary services. Fees are fixed on a per head basis. The fees can be perceived by the slaughterhouse to be transferred to the veterinary services account according to standard procedures. If private veterinarians are used, they will be paid by the veterinary services and not by the slaughterhouse or the owners of the animals.

6.1.2 Pig market operations
The operations of the pig market are located outside the slaughterhouse and should be managed by a separate group of staffs. Do to hygiene considerations these staffs should not have free access to the slaughter facilities.

1. Administrative staff e.g. collecting of fees for the use of the facilities
2. Technical market supervisor
3. Staff (at least 3 workers) to carry out the weighing of animals and the transfer into the pig holding pens and either
   - back to the loading ramp for those animals which are sold alive e.g. for breeding purposes or for slaughter outside the Masaka slaughterhouse
   - to the slaughterhouse

6.2 Educational background and training requirements
According to information found online, the African Institute for Strategic Services and Development (AFRISA) offers a series of training programs in the of pig production value addition and entrepreneurship. These programs which offer courses over one, two, and three years from Artisan skills certificate, Ordinary skills diploma, and Degree target future pig slaughterhouse and abattoir experts, but also Meat quality control technician, Slaughter house and abattoir technician, and Meat inspector.

12 info@afrisa-africa.org
The actual availability of these courses needs however be verified as well as the quality of the courses through cross-checking with graduates of these courses.

Considering the delays until the slaughterhouse will become operational the Cooperative Union should identify key staff for training now in order to have qualified managers and foremen by activity start.

If long term training is not possible or unavailable, ILRI or any of its local partners should prepare and organize courses in quality assurance (QA), HACCP, Good Hygiene (GHP) and Good Management Practices (GMP) for the different levels of staff. Animal welfare should be incorporated in the curriculum of the training program.

Meat inspectors (with a veterinary diploma recognized by the Ministry in charge as qualifying for the task of meat inspection) must receive regular refresher training.
7. Guidelines for treatment of slaughterhouse waste

The best waste treatment system is to reduce waste.

- Dry cleaning before wet clean-up: gathering and sweeping of solid wastes with the use of simple tools and contraptions, i.e., shovels, rubber squeegees and broom, before introducing water,
- Waste segregation by complete bleeding and use of catch containers for blood spillages. Thus less water is required.

Diagram 3: Slaughter flowchart, waste production, waste handling
Slaughterhouse waste is composed of three types of waste:

- **Solid waste**, non-organic wastes like garbage, plastic containers, etc.
- **Liquid wastes**, including all wastewater from the slaughterhouse, holding pens and cleaning of delivery trucks. Liquid waste includes inorganic (mud) and organic substances (feces and stomach content or blood) removed by water during the cleaning process.
- **Butcher waste** composed of inedible residues from the slaughter, condemned parts of the carcass and dead animals e.g. during the lairage. Butcher waste may be contagious; therefore, it is best to treat those on-site.

### 7.1 Solid wastes
This type of waste is collected in special bins and removed to waste collection centers. If an incinerator is used solid waste can also be destroyed on-site.

### 7.2 Method of slaughterhouse wastewater treatment
Slaughterhouse wastewater is one of the specific types of wastewater, which may cause environmental pollution due to high levels of organic matter, suspended residues, N, P and pathogens. Consequently the waste water must be treated before being discharged into the environment (water bodies).

#### Table 2: Water and wastewater standards

<table>
<thead>
<tr>
<th></th>
<th>Slaughterhouse waste water</th>
<th>Maximum tolerance limits[^13]</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.5 - 8.5</td>
<td>6.5 - 7.5</td>
</tr>
<tr>
<td>SS</td>
<td>400 mg/l</td>
<td>100 mg/l into surface water,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>200 mg/l for irrigation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>600 mg/l for public sewers</td>
</tr>
<tr>
<td>COD</td>
<td>4,000 mg/l</td>
<td>25 mg/l into surface water</td>
</tr>
<tr>
<td>BOD</td>
<td>2000 mg/l</td>
<td>30 mg/l into surface water</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100 mg/l for irrigation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>350 mg/l for public sewers</td>
</tr>
<tr>
<td>Total N</td>
<td>400 mg/l</td>
<td>100 mg/l</td>
</tr>
<tr>
<td>Ammonia</td>
<td>200 mg/l</td>
<td>5 mg/l</td>
</tr>
</tbody>
</table>

Waste water treatment has to meet the respective criteria set by the government; e.g. India has 5 levels of water quality from (a) water as drinking source, (B) water for bathing; (c) water for drinking purposes after treatment e.g. chlorination, additional filtering etc., (d) water for aquatic purposes and finally (e) water for industrial purposes and irrigation; Considering the high degree of pollution of slaughterhouse waste water and the costs of water treatment the effluent from the Masaka slaughterhouse should meet at least standard d if disposed directly into the stream/river or (e° if used for trickling irrigation as recommended hereafter.

A wastewater treatment system is composed of several elements shown in the diagram below.

[^13]: http://www.emecs.or.jp/01cd-rom/section_3_e/sec3_a_ro_b_6_e.html
7.2.1 Primary treatment
The pre-treatment consists of the removal of constituents, such as oil, grease, and various solids (e.g. sand, fibers and trash) from the waste water using screens, fat and grease traps and grit chambers (see details and images hereafter). All pre-treatment facilities must be regularly monitored and cleaned to ensure proper functioning. If the maintenance frequency is too low, strong odours can result from the degradation of the accumulated material. The pre-treatment products should be disposed of as solid waste in an environmentally sound way. In the case of grease, it may be used for energy production (e.g., biodiesel or co-digestion, see Point 10).

For the current slaughterhouse project screens and fat/grease traps should be implemented.

7.2.1.1 Screens (static screens)
Screening aims to prevent coarse solids, such as plastics, rags and other trash, from entering a sewage system. Solids get trapped by bar racks and or stainless steel sieves. The usual spacing between the bars is 15 to 40 mm, the sieves are 1mm x 1mm or 1.5 mm x 1.5 mm depending on cleaning patterns. Screens must be cleaned daily by hand or mechanically raked. The latter allows for a more frequent solids removal and, correspondingly, a smaller design.

7.2.1.2 Fat/grease traps
The goal of the fat/grease trap is to catch the oil and grease so that it can be easily collected and removed. Grease traps are chambers made out of brickwork, concrete or plastic, with an odour-tight cover. If designed to be large enough, grease traps can also remove grit and other settleable solids through sedimentation, similar to Septic Tanks.

7.2.1.3 Grit chambers
Grit chambers are used when subsequent treatment technologies could be hindered or damaged by the presence of sand. Grit chambers (or sand traps) allow for the removal of heavy inorganic fractions by settling.
7.2.1.4 Sedimentation tank (3 chamber sedimentation tank)
The rain water collected in the ditches, the water from washing the trucks and the content of the wheel
splashes will be channeled to the sedimentation tank as this water will contain noxious substances for the
biogas digester like oil grease or disinfectants. This tank is usually built of cement, the first chamber is 2.5
to 3 m deep, chamber 2 is 1.2 to 1.5 m deep, and chamber 3 is <1 m deep. Chamber 1 is for keeping
sediments, chamber 2 is for taking floating matters. The sedimentation tank is only used to remove the
majority of insoluble substances in water but is not for treatment of BOD, COD indicators and pathogens.

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14 Available in a range of sizes from domestic to large commercial from e.g. http://www.accepta.com/water-
treatment-chemicals-wastewater-effluent-treatment-products
Considering the location of the planned slaughterhouse on a slope it would be judicious to foresee a sludge removal pipe. This sludge can be composted.

7.2.2 Secondary treatment

Wastewater from a slaughterhouse is very harmful to the environment. Full scale conventional wastewater system such as an anaerobic lagoon, activated sludge and biological nutrient removal technologies is used to treat wastewater from slaughterhouse but they are expensive. For rural slaughterhouses low cost solutions need to be implemented. Rural slaughterhouses can apply some low cost types of secondary treatment to minimize the pollutant before going out to the environment as shown in the following diagram such as cleaning the biogas effluent through a fishpond, a lagoon, a planned gravel filter or by applyingtrickling irrigation. Because of the potential residues of enterobacteria the effluent should not be used on any crops eaten raw (e.g. vegetables or fruits such as strawberries). Irrigation of orchards, banana plantations etc. do not represent any risk,
7.2.2.1 **Biogas digester**

The capacity of the anaerobic tank is dependent on the size and capacity of the slaughterhouse. To ensure that anaerobic fermentation process is done thoroughly, the tank should have sufficient space for receiving the wastewater collected in 20 days of operation. For the planned slaughterhouse handling up to 50 pigs per day the biogas digester must have a volume of 15-20m³.

In order to get technical and maybe financial support, contacts should be made with local projects working on biogas facilities such as the National Biogas Program, SNV, GTZ, and Heifer International.

Below is presented only a short outline on the biogas digester, considering different options.

- **Fixed dome digesters using concrete blocks** (see figure hereafter)
  - Construction material is available in most of rural areas of Uganda;
  - Thanks to the dome-shaped of wall, the digester resists to compress force and helps saving on construction material;
  - If manufactured with good quality of materials and properly managed, the digester has long lifetime;
  - As constructed underground, the land above can be used for the construction of animal shed;
  - No bad odour, clean bio-slurry if good construction and operation are well managed

  However:
  - Masons need to be trained for this task
  - Difficult to detect damage or repair damage

- **Prefabricated composite biogas digesters**
  - Gas-tight and water-tight
  - Saving on construction site (prefabricated device)
  - Save time for installation; do not need trained masons because composite installation is implemented by technicians of suppliers/manufacturers
  - Suitable to weak soil and high water table soil
Can be moved to another location when necessary
Simple operation and maintenance
Odourless if good operation

However:

- High investment cost;
- Difficult transportation

Figure 23: Biogas digester models

Fixed dome digester
1. Mixing tank, 2. Inlet pipe, 3. Digesting tank, 4. Dome-gas pipe,
5. Outlet pipe, 6. Compensation tank

Prefabricated composite digester

The main benefits of a biogas digester derive from

- Methane gas production which can be used for heating cooling or running of generators
- The sludge can be used as fertilizers (additional composting to dry the sludge and to destroy a maximum of health hazards should be considered)

The effluent from the biogas digesters needs to undergo further treatment using either of the following three methods:

- Fish ponds,
- Lagoons or biological ponds,
- Irrigation.

Using fish ponds is an additional source of income for the slaughterhouse besides the biogas products, namely methane gas which can be used for heating of water and the biogas sludge which can be sold as fertilizer

7.2.2.2 Fish ponds

Biogas effluent is widely used in South East Asia to produce fish\(^\text{15}\). Processing pig manure in an anaerobic biodigester, before using it as fertilizer for ponds stocked with a fish polyculture may result in a 55% increase in net fish growth compared with direct application of the fresh manure. All of the five fish species (Tilapia, Silver carp, Bighead carp, Silver barb and Mrigal) were found to grow faster in ponds fertilized with effluent than with manure.

\(^{15}\) Effect of processing pig manure in a biodigester as fertilizer input for ponds growing fish in polyculture by Pich Sophin and T R Preston from Proceedings Biodigester Workshop March 2002 (www.mekarn.org/procbiod/Pich.htm): Effluent from biodigesters with different retention times for primary production and feed of Tilapia (\textit{Oreochromis niloticus}), San Thy and T R Preston
Paddy ponds are made in places where the ground is flat, or almost flat, such as in dambos or swamps and flood plains. The water for the ponds comes in a furrow from a stream, or from seepage in the area, or sometimes from springs. Because paddy ponds are made on flat ground, four walls must usually be made to each pond, as compared with three for contour ponds and only one for barrage ponds. The water supply often needs to be brought to the ponds on top of a specially constructed dike and is distributed by furrows on top of the pond walls. The walls of paddy ponds are of a wider construction than the walls of other kinds of ponds because the soil is usually not so firm.

Figure 24: Cross section of fish pond

7.2.2.3 Lagoons or biological pond (usually, 3-5 ponds):
Biogas effluent is led into the lagoon which uses aquatic plants like hyacinths to increase the efficiency of natural treatment. Mechanism of pollutant disposal of the systems is mainly through sedimentation and biodegradation. Good results have also been achieved with Vetiver grass (Vetiveria zizanioides) which has been introduced as a new phyto-technology for various environmental protection applications. Vetiver grass is a “super absorbent” plant, mainly used for soil conservation, with a strong root system, which can develop as deep as 5 m. It is able to penetrate compacted soil layers and has minimal lateral growth. Vetiver grass has been used for the disposal of leachate and effluent generated from landfill and wastewater treatment plants in Australia, China and Thailand. The model of a biodigester tank followed by Vetiveria zizanioides L. is suitable for treating wastewater from a slaughterhouse, reaching the standards of the Vietnamese Technical Regulation on Industrial Wastewater in all criteria except for total P and total coliforms.

Figure 25: Lagoon
### 7.2.2.4 Planted gravel filter

By passing through the gravel and plant roots (planted with common reeds) wastewater comes into contact with oxygen.

![Cross section of gravel filter](image)

![Empty gravel filter](image)

### 7.2.2.5 Irrigation

An alternative to fishponds, lagoons or gravel filters can be an irrigation system in which the biogas effluent is channeled through buried pipes directly to the roots of trees (trickling irrigation). If possible, the location should be appropriate for gravidity irrigation.

### 7.2.2.6 Composting (see also hereafter: Handling of butcher waste)

Valuable sources of nitrogen are manure, rumen contents and condemned materials (soft animal tissues) and to a certain extent also hairs and hooves.

These combined with dried leaves or other carbon sources are composted for fertilizers or soil conditioner.

It is however important to respect the distances of the pile from water sources. In the case of the site for the Masaka slaughterhouse it will be necessary to acquire land outside the existing plot for the composting unit.
7.3 Handling of butcher waste

Safe meat value chains have to provide solutions for all hazards along the operation from farm to consumer. With regard to slaughterhouse operations this includes the aspect of how to handle potentially pathogenic waste (e.g. from dead or culled animals, or from condemned animal byproducts (ABP) during the slaughter process. In fact, low cost traditional methods of destruction of animals and pathogenic ABP like burial/landfill or burning/pyre are hazardous.

Well managed composting is considered as a reasonable intermediary solution, appropriate for inedible ABP including hair and hooves. The temperatures in compost piles/bins of + 55°C are sufficient to reduce most pathogenic viruses, bacteria, protozoa and helminth ova, however endospores producing bacteria like the Anthrax agent are not inactivated.

Rendering is another method used for the disposal of animal waste products however the process does not destroy BSE psions. Therefore in countries with BSE risk rendering has become less popular in particular as the final product like meat and bone meal cannot be used any longer as cheap protein feed source. Uganda had been free of BSE and producing meat and bone meal from pig by-products should be acceptable. However, with regard to the situation of the planned Masaka slaughterhouse the small amount of slaughter waste from inedible/unfit for human consumption parts of slaughtered animals and even from dead animals at farm level does not justify the investment in the constructions of rendering units (equipment price is about US$100000 for the smallest unit), although they are producing valuable end products like fat, or meat and bone meal for animal feeding. In fact, well managed rendering plants generate benefits for the operator even if paying for the ABP.

In contrast to customary burning, properly operated incineration facilities pose fewer pollution concerns. Also, bacteria (including spore-formers) and viruses should not survive the incineration process. Costs of such incinerators are < US$20000.

The different approaches are assessed and their advantages and disadvantages, including the risk to human health are presented in the document in Annex 4.
With regard to small scale slaughterhouse operations composting should be considered as a complementary form of processing of the biogas slurry as well as the condemned or inedible animal byproducts. Compost can be sold as high quality fertilizer as it is almost “sterile” compared to normal biogas sludge which contains in general enterobacteria.

Figure 28: Composting with windrows piles

<table>
<thead>
<tr>
<th>Windrows/piles 16</th>
<th>Windrows/piles 17</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. In the windrow process garbage is laid in long heaps above ground and oxidation and fermentation is carried out by regular turning thereby keeping air, moisture and temperature under control till it gets stabilized</td>
<td></td>
</tr>
<tr>
<td>b. Windrows are generally built up to be 1.5m high and 3m wide.</td>
<td></td>
</tr>
<tr>
<td>c. Windrows need to be fenced to keep stock and scavengers out</td>
<td></td>
</tr>
<tr>
<td>d. The final pile is cone shaped, 2.4–3.6 m (8–12 ft) wide at the base and 1.2–1.8 m (4–6 ft) tall at the highest point</td>
<td></td>
</tr>
</tbody>
</table>

16 [http://www.omafra.gov.on.ca/english/engineer/facts/09-017.htm](http://www.omafra.gov.on.ca/english/engineer/facts/09-017.htm)
17 [http://cwmi.css.cornell.edu/spaceittakes.pdf](http://cwmi.css.cornell.edu/spaceittakes.pdf)
7.4 Biofuel production from grease and fat

Biodiesel can be made from domestically produced crops, animal fat and waste vegetable oil. It is biodegradable making it safe to handle and transport.

Figure 29: Biodiesel unit

- Animal fats are attractive feedstocks for biodiesel because of their low costs
- Animal fat feedstocks can be made into high-quality biodiesel
- One of the important attributes of biodiesel is that it lowers the levels of harmful pollutants in the exhaust of diesel engines.
- Biodiesel can be used as fuel for a boiler or heater in the slaughterhouse

18 [www.bioman.co.za](http://www.bioman.co.za) and [http://www.extension.org/pages/30256/animal-fats-for-biodiesel-production](http://www.extension.org/pages/30256/animal-fats-for-biodiesel-production)
8. Sanitation

The aim of food hygiene is to assure clean, safe and wholesome food. However, during the slaughtering process meat, which is practically sterile, is exposed to contamination with bacteria from the outside surface and intestines of the animal, from equipment such as knives, saws, hooks and so on, and from the air and the hands of the workers. When equipment is not regularly cleaned therefore, there is a building up of bacteria which shortens the shelf-life of the meat and could also cause food poisoning in consumers. Proper sanitation will reduce the amount of bacteria in all work areas and on the equipment, and therefore has a direct effect on the quality of the meat provided to the consumer.

8.1 Requirements for cleaning and disinfecting the abattoir and equipment

It is extremely important for the management of an abattoir to be fully informed of their duties in respect of hygiene. If they are not, a tendency could arise to favour production efficiency to the detriment of hygiene, or even attempt to economize on cleaning and disinfecting materials.

- All equipment, implements, tables, containers, disposal chutes, etc. must be made of a material that can be easily cleaned and sterilized.
- All parts of an abattoir as well as fixed articles, equipment, tables and implements must be kept clean and in good condition to the satisfaction of the meat inspector.
- All parts of the abattoir, as well as all partitions, equipment and utensils used in the abattoir and which come into contact with the carcass, meat or animal product, must be thoroughly cleaned and disinfected at the end of the working day, or more frequently should it be required.
- All machinery and equipment used in an abattoir must be designed and situated in such a way as to be easily accessible for cleaning. All equipment used in an abattoir must always be kept in a clean, protected state when not in use.
- Equipment such as fillers, boilers, autoclaves, digesters and mixer tanks must, when not in use, be kept at a temperature that inhibits the growth of heat resistant micro-organisms.
- All equipment that has been in contact with bile, faecal or disease-infected material must be cleaned and sterilized immediately before re-use.
- Metal brushes or steel wool may not be used, because they damage the surface of the equipment; this makes proper cleaning and disinfection difficult.
- Cloths must not be used for drying, as this only spreads contamination.
- No polish or other substance that contains any poison may be used for the cleaning or polishing of equipment. All such substances must be subject to approval by the competent authorities.
- After cleaning all utensils and surfaces of equipment, the abattoir must be thoroughly disinfected, including the floors and walls.
- The disinfection of an abattoir and its equipment, which is infected by a contagious human or animal disease, must be done in a way and with a disinfectant approved by the competent authorities.
- The holding area must also be thoroughly cleaned and when necessary disinfected.
- A water supply of at least 200 liters per slaughter unit in the case of pig abattoirs should be available to protect against contamination, and the quality of this water must meet certain requirements.
- A satisfactory supply of hot water at a minimum temperature of 40 - 50°C must be available at all times during working hours where necessary for cleaning.

It is the responsibility of the abattoir owner to ensure that the premises are kept as free as possible from rodents, birds, cats, dogs, flies and other insects at all times, and that no breeding place or circumstances are permitted on the premises which could encourage the breeding of vermin.

8.2 Pre-operational check
In order to check up on the effectiveness of the cleaning and disinfection processes, it is very important to inspect the slaughter floors and equipment first thing in the morning. If there are any problems, there is still time to re-clean properly before slaughtering begins. A pre-slaughter inspection of the abattoir is essential.

A visual inspection of the abattoir and equipment will reveal immediately any traces of meat, fat, blood and other contaminants that have not been removed. These remnants are highly undesirable, as they attract insects and rodents while serving also as an excellent growth medium for bacteria.

During inspection the senses of smell, sight and touch are employed and samples are taken for bacteriological analysis. Odours in an abattoir can give a reliable indication of whether the cleaning and disinfection processes have been carried out properly.

While bad odours such as rotting meat immediately indicates ineffective cleaning procedures, an excessive smell of chemicals is also undesirable, as it can easily mask bad odours, and meat is also well known for its ability to absorb odours.

8.3 The practice of cleaning and disinfection
The seven (7) basic steps of cleaning and disinfection:

- Removal of loose bits of rubbish such as meat, fat, skin and bone from equipment walls and floors to facilitate cleaning.
- Loosening pieces of rubbish, blood, faeces and other contaminants by means of dry sweeping, and removing them by picking them up. Bits of meat and fat and skin, in particular, must not be washed into the drainage system.
- Pre-washing all equipment, floors and walls with clean hot water (40 - 50°C) to soften and loosen the remaining particles.
- Washing and scrubbing with detergents and hot water under pressure.
- Rinsing with clean hot water (45 °C) under pressure in order to remove the loosened particles and detergents properly.
- Disinfecting with a suitable disinfectant at the proper concentration.
- Microbiological survey of the equipment and walls to establish the effectiveness of the cleaning and disinfecting.

Two other important factors to remember is that condemned material and trimmings must be put into containers and not thrown on the floor, and racks and reels must be provided for brooms and hoses.

GOOD SANITATION IS 90% CLEANING AND 10% DISINFECTION!
8.4 Do's and Don'ts with sanitation programmes
A sanitation program for each work area is essential. Cleaning and disinfection is just as essential for the production of a safe product of high quality as any other part of the program.

8.4.1 DO!
- Remove gross dirt such as scraps, fat, meat juices and other organic matter before applying the detergent foam or solution.
- Always rinse with warm water (40-50°C).
- Foam or scrub with detergent solution (60-70°C).
- Allow a contact time of 10 minutes for foam.
- Use disinfectants at the recommended concentration only.
- Drain equipment and store dry where possible.

8.4.2 DON'T!
- Misuse of chemicals - both overuse and under-use is wasteful.
- Use cold water - it increases your chemical requirements.
- Mix different chemicals without the manufacturer’s instructions they may react dangerously or may neutralize each other.
- Add chemicals to foodstuffs.
- Rinse after sanitizing - allow to air dry.
- Use pieces of cloth (rags) anywhere - it facilitates contamination of surfaces and products.

Table 2: Template\(^{20}\) of a cleaning plan for a slaughterhouse (to be recorded in record book) and verified by the meat inspector

<table>
<thead>
<tr>
<th>Location</th>
<th>daily</th>
<th>weekly</th>
<th>monthly</th>
<th>Procedure</th>
<th>Products used(^{21}) (trademark and concentration)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling, walls, installation</td>
<td>x</td>
<td></td>
<td></td>
<td>After end of operation, water with detergents, rinsing with cold water</td>
<td></td>
</tr>
<tr>
<td>Floor and drainage</td>
<td>x</td>
<td></td>
<td></td>
<td>Use of water with detergents, broom</td>
<td></td>
</tr>
<tr>
<td>Knives, hooks other stainless equipment</td>
<td>x</td>
<td></td>
<td></td>
<td>Water with detergent, brush, rinsing, disinfection prior to use</td>
<td></td>
</tr>
<tr>
<td>Saws and choppers</td>
<td>x</td>
<td></td>
<td></td>
<td>Water with detergent, brush, rinsing, disinfection prior to use</td>
<td></td>
</tr>
<tr>
<td>Basin for disinfection</td>
<td>x</td>
<td></td>
<td></td>
<td>Emptying of disinfection solution into a bucket (not to be drained to biogas tank, cleaning with brush and water</td>
<td></td>
</tr>
<tr>
<td>Hand wash</td>
<td>x</td>
<td>x</td>
<td></td>
<td>When empty, see ceiling and walls</td>
<td></td>
</tr>
<tr>
<td>Store room</td>
<td>x</td>
<td>x</td>
<td></td>
<td>Broom, cleaning with water, use of pressure cleaner recommended</td>
<td></td>
</tr>
<tr>
<td>Reception/delivery area outside of building</td>
<td>x</td>
<td></td>
<td></td>
<td>Daily verification and replenishment, at least monthly changing of disinfection solution</td>
<td></td>
</tr>
<tr>
<td>Wheel splashes</td>
<td>x</td>
<td>x</td>
<td></td>
<td>Verification e.g. building up of algae, mould, re-adjustment of chlorination</td>
<td></td>
</tr>
<tr>
<td>Other Water tank/reservoir</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{20}\) This plan has to be adjusted according to a HACCP assessment
\(^{21}\) Products for cleaning and disinfection are described in Annex 9. Veterinary Service will prescribe products according to local availability
9. Cost estimates and links

The cost estimate is based on the use of good quality materials ensuring a lifespan of 12 years. Probably costs can be reduced by using lower quality materials, but this needs to be reflected in the economic calculations e.g. depreciation costs.

Internet portals like Alibaba or Indiamart offer in general economical prices for livestock equipment shipped to destination. The customer has to assume custom clearance and is requested to pay the goods before shipment. Consequently it is better to identify local providers even if their prices are higher as the offer after sale services and spare-parts.

Table 3: Cost estimate for Masaka slaughterhouse

<table>
<thead>
<tr>
<th>#</th>
<th>Designation</th>
<th>Cost US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Basic slaughterhouse</td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Earthwork</td>
<td></td>
</tr>
<tr>
<td>1.1.1</td>
<td>Excavation, compacting, filling, eventually protective wall against landslides</td>
<td>Do be determined by a civil engineer</td>
</tr>
<tr>
<td>1.1.2</td>
<td>Access road</td>
<td></td>
</tr>
<tr>
<td>1.1.3</td>
<td>Drilling of well</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Foundation, 20 m * 35m * 10 cm</td>
<td>8,000</td>
</tr>
<tr>
<td>1.3</td>
<td>Steel construction of slaughterhouse 15 x 30x 6-8m, with roofing, CIF Mombassa</td>
<td>25,000</td>
</tr>
<tr>
<td>1.3.1</td>
<td>Masonry including pig pens</td>
<td>15,000</td>
</tr>
<tr>
<td>1.3.2</td>
<td>Plumbing (water taps, sinks, toilets)</td>
<td>8,000</td>
</tr>
<tr>
<td>1.3.3</td>
<td>Electricity (lamps, sockets, installation of winches for hoists)</td>
<td>5,000</td>
</tr>
<tr>
<td>1.3.4</td>
<td>Sewage (drains, fat traps, screens, septic tank)</td>
<td>12,000</td>
</tr>
<tr>
<td>1.4</td>
<td>Slaughter lines (2)</td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>Water storage (tank, filters, chlorination)</td>
<td>10,000</td>
</tr>
<tr>
<td>1.6</td>
<td>Electric installation and electric equipment</td>
<td></td>
</tr>
<tr>
<td>1.6.1</td>
<td>Pumps (2)</td>
<td></td>
</tr>
<tr>
<td>1.6.2</td>
<td>boost pump</td>
<td></td>
</tr>
<tr>
<td>1.7</td>
<td>Walls, wheel splashes, gates, asphalting, unloading ramp inside slaughterhouse</td>
<td>12,000</td>
</tr>
<tr>
<td>1.8</td>
<td>Waste-water treatment (ditches, biogas digester for a 50 pig slaughterhouse, compost pit, fish pond</td>
<td>20,000</td>
</tr>
<tr>
<td>1.9</td>
<td>Mechanical weighing scale</td>
<td>1,000</td>
</tr>
<tr>
<td>1.10</td>
<td>Furniture, office equipment</td>
<td>5,000</td>
</tr>
<tr>
<td>1.11</td>
<td>Stock of chemicals (chlorination, cleaning)</td>
<td>5,000</td>
</tr>
<tr>
<td>1.12</td>
<td>Tools (rakes, shovels, pressure cleaner)</td>
<td>5,000</td>
</tr>
<tr>
<td>1.13</td>
<td>Connection to public electricity (poles, wire eventually transformer)</td>
<td>8,000</td>
</tr>
<tr>
<td></td>
<td>Total cost of infrastructure (earthwork excluded)</td>
<td>176,000</td>
</tr>
<tr>
<td>2</td>
<td>Optional equipment for slaughterhouse</td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Cold store</td>
<td></td>
</tr>
<tr>
<td>2.1.1</td>
<td>Second refrigerated container</td>
<td>10,000</td>
</tr>
<tr>
<td>2.1.2</td>
<td>Second hand refrigerated truck</td>
<td>10,000</td>
</tr>
<tr>
<td>2.2</td>
<td>Dehairing machine/scalding dehairing machine²⁴</td>
<td>4,000</td>
</tr>
<tr>
<td>2.3</td>
<td>Bio fuel unit, 50 liters batch processor</td>
<td>5,000</td>
</tr>
<tr>
<td>3</td>
<td>Pig market</td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Pig holding pen</td>
<td>10,000</td>
</tr>
<tr>
<td>3.2</td>
<td>Pig quarantine pen</td>
<td>2,000</td>
</tr>
<tr>
<td>3.3</td>
<td>Pig race, crushes</td>
<td>2,000</td>
</tr>
</tbody>
</table>

²² material for the slaughterhouse may however follow under tax /custom duty free items see under 1.4.2 incentives for the livestock sector

²³ lukelu@chinahonkae.com, steel1@sd-hongyuan.cn, sales8@putianhouse.com, mu@lstianjun.com

²⁴ http://www.njxps.cn/
9.1 Assessment of potential options
Considering the high investment costs of the planned slaughterhouse some alternatives are presented hereafter. The costs of each option are estimated and presented in Table 4 hereafter.

Considered options:
1. Slaughterhouse for 20 to 25 pigs per day with 170 m² floorage
   This size meets the actual requirements of the cooperative union. The design of this slaughterhouse is shown in Annex 8
   Advantages:
   - Lower investment and construction costs for abattoir and biogas digester
   - Fits in the available plot
   - Direct access road to slaughterhouse and compost unit can be constructed in the same plot.
     However if the option of adding a pig market to the slaughterhouse is maintained, additional land is needed for an access road outside the slaughterhouse)
   Disadvantages:
   - Expanding the slaughterhouse and waste water cleaning will be complicated
   - Additional land for expanding may not be available any longer

2. Slaughterhouse with a capacity for 50 pigs in two bay slaughter-lines of 25 pigs each.
   The core element of this slaughterhouse is a metal construction that can host two slaughter-lines of 25 pigs each. In the first stage only one slaughter-line will be installed, the number of pig pens are reduced, the free space can be used for storage of other products e.g. fertilizer, etc. When the number of pigs to be slaughtered increases the second line can be easily added in the free space.
   Advantages:
   - Construction of 1 slaughter-line, reduced number of pens)
   - Investment costs can be spread over a longer period (construction of second line)
   - The proposed design can be fitted in the available plot (as shown in Plan 3)
   Disadvantages:
   - Higher costs for the metal construction due to the larger floorage (about 310 m²). Metal constructions with roofing and side walls are priced between US$ 60 to 80 per square meter, without metal walls at about US$45 per square meter. Options like transparent roofing are available as option with a supplement
3. Slaughterhouse with a capacity for 50 pigs in two bay slaughter-lines of 25 pigs each
Both slaughter line are installed and used respectively for cooperative members and third party slaughtering.
Advantages:
  o This option allows a separation of animals from cooperative members and third parties in the light of branding of products
Disadvantages:
  o The entire investment costs have to be raised

4. Decentralized small scale slaughterhouses with a capacity of 10 pigs each
This option – including plan and photos - is presented in Chapter 11: Recommendations
Advantages:
  o The costs of such as small scale slaughterhouse is relatively low (approx. US$ 2000 including a biogas and small scale composting unit).
  o Slaughterhouses can be built in the vicinity of the different cooperative societies. This will reduce transport costs to the slaughterhouse.
  o Reducing transport should result on lowering the risk of spreading diseases
  o Local slaughterers and butchers can be integrated e.g. as contract slaughterhouses. Arrangements of cost sharing to build the small scale slaughterhouses can be negotiated (e.g. the slaughterer/butcher provides the land and the bare brickworks (skeletal construction) and the Cooperative Union assumes the costs in form of a grant or a loan for the interior construction (tiling), equipment biogas digester
Disadvantages:
  o The effluent of biogas digesters does not meet the general requirements for clean water which can be channeled directly into public streams, rivers or lakes. Secondary cleaning is therefore necessary whereby the option of trickling irrigation seems to be the most cost efficient, if the location allows a fishpond can also be constructed.
  o Setting up meat inspection is more complicate unless local private meat inspectors are hired (sanitary mandate and training of private service providers in meat inspection are prerequisites)
  o Regular control of GMP and GHP through cooperative societies is required
  o The required waiting time in the lairage area of 12 hours may not be fulfilled as these slaughterhouses will not have a full-fledged lairage area but only the small pen which olds the pigs for a limited period between arrival and slaughter

Table 4: Comparison of costs for alternative solutions

<table>
<thead>
<tr>
<th>Cost elements</th>
<th>Slaughterhouse options (see above)</th>
<th>Option 1 20-25 pigs/d</th>
<th>Option 2 50 pigs /d abattoir with one slaughter line</th>
<th>Option 3 50 pigs/d with 2 operational slaughter lines</th>
<th>Small scale abattoir (price for 1 unit with a capacity of 10 pigs/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plot development</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earthworks like excavation, filling,</td>
<td>Cost to be identified by identical</td>
<td>Cost to be identified</td>
<td>Cost to be identified by identical options 1 -3</td>
<td>Depends on selected sites, in particular with regard to road access</td>
<td></td>
</tr>
<tr>
<td>landslide protection</td>
<td>options 1 -3</td>
<td>options 1 -3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access road</td>
<td>12,000</td>
<td>12,000</td>
<td>12,000</td>
<td>4,000</td>
<td></td>
</tr>
<tr>
<td>Well drilling</td>
<td>18,000</td>
<td>18,000</td>
<td>18,000</td>
<td>1,000</td>
<td></td>
</tr>
<tr>
<td>Fence, walls, wheel splashes,</td>
<td>8,000</td>
<td>8,000</td>
<td>8,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>unloading ramp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water tank including pumps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric power connection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foundation</td>
<td>5,000</td>
<td>8,000</td>
<td>8,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steel construction or brick building</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12,000</td>
</tr>
<tr>
<td>Description</td>
<td>20,000</td>
<td>25,000</td>
<td>25,000</td>
<td>2,000 without pen</td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------------------------------------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>-------------------</td>
<td></td>
</tr>
<tr>
<td>Masonry including pig pens</td>
<td>7,000</td>
<td>10,000</td>
<td>15,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plumbing, electricity</td>
<td>10,000</td>
<td>13,000</td>
<td>13,000</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Sewage including septic tank</td>
<td>8,000</td>
<td>12,000</td>
<td>12,000</td>
<td>1,000</td>
<td></td>
</tr>
<tr>
<td>Slaughter-line including scale at pig reception</td>
<td>15,500</td>
<td>15,500</td>
<td>30,000</td>
<td>4,000</td>
<td></td>
</tr>
<tr>
<td>Waste treatment (biogas, lagoons, fish pond, gravel filter, compost unit)</td>
<td>15,000</td>
<td>20,000</td>
<td>20,000</td>
<td>3,000 Biogas tank of 10m³, compost bin</td>
<td></td>
</tr>
<tr>
<td>Furniture, equipment</td>
<td>3,000</td>
<td>5,000</td>
<td>5,000</td>
<td>1,000</td>
<td></td>
</tr>
<tr>
<td>Tools, Chemicals</td>
<td>3,000</td>
<td>4,000</td>
<td>10,000</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>124,500</td>
<td>150,500</td>
<td>176,000</td>
<td>29,000</td>
<td></td>
</tr>
</tbody>
</table>
10. Conclusions

The available plot is not ideal for the set-up of a slaughterhouse with the capacity of 50 pigs, because it will involve heavy costs for plot development. The Masaka Local Government should be requested to award additional land on the west side of the plot, and to contribute with the costs of preparing the plot for construction works.

In addition the constraint of maintaining an existing building does not allow to build the fresh water and waste water system in the appropriate way which is to dig the well on the southern side of the plot (near to the water catchment area of the municipality and to build the waste water system (sedimentation tank, biogas digester, fish ponds downstream. This will avoid any accidental contamination of the well (see alternative set-up here after)

Plan 5 : Alternative set up of slaughterhouse
11. Recommendations

11.1 Introduction of cuts to improve benefits
For the moment there exist only one price for meat in Masaka which is approx. UGX8000 per kilo. Using standard cuts as shown hereafter targeting well-off urban consumers may increase the benefits. This option should be combined with a branding process (see section 10.2)

Figure 30: Pork cuts

11.2 Branding (use of stamps on meat from cooperative members)
A brand can be developed by anyone who has the skill, knowledge and funding required to build a strong and recognizable brand. Any name can become a brand if it is recognized and valued by the relevant target consumer group. A brand does not need to be registered but it can be converted into a trademark which is registered and protected by the authorities.

Brands are usually products belonging to one company, which are known by a specific name, image, logo, slogan, or even packaging. The brand makes it easy for consumers to identify the product and promises consistency and quality as well as any other brand values the company promotes. These brand values are associated by the consumers or customers to the brand and they are often prepared to spend extra for these branded products and the reassurance they provide.

The slaughterhouse is a great starting point to initiate a brand. In addition to the stamp of meat inspection stamps with a logo of the Cooperative Union could be applied on the meat using non-toxic food safe ink of the same quality as the meat inspection ink.
Branding together with a public awareness campaign and the presentation of meat in different cuts will most likely attract well-off customers.

11.3 Introduction of Good Animal Husbandry Practices (GAHP)
Although slaughterhouses are an important part of safe food as meat is inspected. However, food safety starts already at the farm level.

The Cooperative Union should make efforts to convince their members to use better breeding material to produce larger and leaner pigs under good husbandry practices which include appropriate pig housing, balanced feed, sufficient clean water, disease prevention through vaccinations, hygiene measures e.g. regular cleaning and disinfection of the pens, protection against rodents and insects, foot baths at the entry to the pens, restriction of visits by persons not belonging to the household.

Other important aspects are animal welfare and environmental protection:

- Raising pigs in a stress free environment (not shouting or beating of animals) under GAHP conditions and providing some distraction (typical signs of bored fatteners are cannibalism like biting of ears and tails) has proven positive effect on the health of the animals and on the production efficiency.

Animal welfare also concerns the transport of animals to the slaughterhouse during which stress should be reduced as stress has a direct impact of the meat quality and the shelf life of the final product.

- Pig production like any form of livestock production is polluting the environment when waste and waste water is disposed of in an uncontrolled manner. The example of smallholder farms in Asia have shown that even with ( pigs a small biogas digester can be operated which converts livestock waste into energy and reduces the negative impact of polluted farm waste water.

25 http://livestockfish.cgiar.org/2012/05/04/smallholder-pigs-value-chain-project-to-increase-rural-incomes-in-uganda/
The application of GAHP (good animal husbandry practices) could contribute to increasing the profit by reducing mortality and morbidity rates, faster weight gain through better feed conversion, consequently shorter fattening periods and higher weight of finished pigs (depending on the breed used).

11.4 Small scale slaughterhouses instead of central large scale slaughterhouse
The objective of the present study was to design a modern slaughterhouse in which pigs can be slaughtered under good conditions producing safe and hygienic meat.

The decision to regroup pig producers in a Cooperative Union which uses jointly this slaughterhouse is a judicious decision as hygienic measures can be easily introduced and veterinary inspection/supervision can be implemented in such a central structure.

However transporting animals from different locations in vehicles which may not correspond to the norms of hygienic and safe livestock transport conditions may entail the risk of spreading diseases unless the animals had been inspected at the point of departure by a veterinarian who confirms the health of the animal with a movement /health certificate.

Decentralized small scale slaughterhouses can also satisfy the requirement for food safety and the refurbishing/construction of several small scale slaughterhouses achieving the same output as the planned central slaughterhouse may even be less expensive as the central structure.
As the Masaka slaughterhouse will be mainly funded by the members of the Cooperative Union and not by a grant, cost benefit analyses for this alternative and any other option should be made.

Figure 31: Floor-plan for small scale slaughterhouse up to 10 pigs per day

As slaughtered pigs are from the vicinity of the slaughterhouse (short transport) the 12 hours lairage requirements may be shortened if ante mortem inspection can be carried out in the farms (this is a common procedure in rural areas of Germany).

Pictures of hygienic small scale slaughterhouses

<table>
<thead>
<tr>
<th>Tiled slaughter room</th>
<th>Stainless steel tables and rack for hanging up the carcasses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stainless steel scalding table and restrainer</td>
<td>Biogas digester and composting bin</td>
</tr>
</tbody>
</table>

Figure 32: Small scale slaughterhouse as promoted by ASVELIS; Vietnam

Small-Scale poultry slaughterhouse in Vietnam.

- Adapted from France.
- Initial investment = USD 15,000.
- Capacity: up to 500-1,000 poultry per day.
- Can be used for 10-50 pigs per day with some adjustments.

---

26 Gauthier, Patrice: Good practices for pork value chains in emerging countries, ASVELIS; Hanoi 2012
12. Bibliography

This bibliography is neither exhaustive nor exclusive.

3. CTA/FAO: Rural structures in the tropics, design and development, 2011
4. Design of plumbing systems for industrial and temporary applications
5. EBRD Sub sector Environmental and social guidelines 2014 on slaughterhouses
6. FAO Standard design for small scale modular slaughterhouses, Animal production and Health Paper 73, 1988
7. FAO, Abattoir development. Options and design for hygienic basic and medium sized abattoirs, RAP Publication 2008/1
9. FAO. Abattoirs et postes d’abattoirs, dessin et construction
10. FAO. Design and equipment for small scale slaughterhouses
11. FAO. Fish culture in Central East Africa. Fisheries and Aquaculture Department, 1966
12. FAO. Management of waste from animal product processing.
13. FAO. Manual on meat cold store operation and management. Animal Production and Health paper 92,
14. FAO. Meat processing technology for small- to medium-scale producers.. RAP Publication 2007-20,
15. FAO. On farm composting methods, 2003
17. FAO. Standard design for small-scale modular slaughterhouses.
18. Fish pond site selection and construction, Extension bulletin 96, Fisheries series 2, Ahmadu Bello University, Zaria, 1994
19. GATE/GTZ; Anaerobic treatment of slaughterhouse waste and wastewater. 2001
20. Good manufacturing practices for abattoirs, Thai Agricultural Standards, MAC Thailand, 2005
23. MARD Ethiopia. Meat Cold Chain Guideline, 2009
26. Oxfam Guideline for water treatment
27. Pilot integrated waste management scheme for small and medium scale slaughterhouses. Animal Products, Development Center, Philippines
28. Workshop on biological treatment of biodegradable waste, EC rules for composting and biogasification of animal by-products
Annex 1: Terms of reference

CONSULTANT NAME: Michael Handlos ASSIGNMENT/PROJECT NAME: COUNTRY OF ASSIGNMENT:

1) GENERAL BACKGROUND
In Uganda, the smallholder pig value chain has been identified by the Livestock and Fish CGIAR program as one of the livestock options where research investments are most likely to make a major difference to the livelihoods and diets of poor people. ILRI, with the support of IFAD/EU, has been conducting research on the pig value chain, the challenges and opportunities for improving the pig/pork sector. Among the interventions identified for piloting include the need for proper slaughtering facilities to assure hygienic process and facilitate veterinary inspection and disease control. In all districts where the project operates there is lack of such facilities; therefore the effort to be done through the consultancy will serve as a model for other districts. The Masaka Local Government has taken the initiative to allocate land for a slaughterhouse, and the SPVCD project decided to support this partner by hiring a consultant who will assess the feasibility of the intervention based on the design of a facility that responds to the prevalent conditions in the district.

2) OBJECTIVE OF THE ASSIGNMENT
To propose a design of the slaughterhouse for pigs that respond to the needs and conditions of Masaka district. However, the design could serve as a model for other districts interested in a similar initiative.

3) SCOPE OF WORK
The consultant will work with the ILRI team and partners in the local government of Masaka district analyzing different design options for improved pig slaughtering in the district, using the area allocated for that purpose by the local government. The design should consider the number of pigs currently slaughtered in the Masaka town area (ca. 20 pigs per day), but also the possibility of expanding it to cover a greater demand in case pigs are slaughtered for the Great Kampala markets as well (up to 50 pigs per day). The activities to be performed are as follows:

• To evaluate the current slaughtering volumes, practices and facilities used in the pig value chain in Masaka district.
• To assess the appropriateness of the land assigned by the local government for building the slaughterhouse, including access to basic services (i.e., water, electricity) needed for the operation of the slaughterhouse, including proper management of wastes. If not adequate, should recommend options for upgrading those services.
• To prepare at least two design options for the slaughter facility: (a) For 20 pigs, considering that will respond to the current needs, assuming that 75% of the pigs slaughtered in Masaka are taken to the proposed abattoir; and (b) For 50 pigs considering that most pigs produced in Masaka are slaughtered in the district, and the carcasses transported to the Greater Kampala.
• To prepare a list of equipment required for proper operation and estimated costs (if possible propose potential providers) for the option responding to the current volume of slaughtering.
• To estimate the costs associated to the construction of the slaughtering facility; information that will be shared with an economist who will analyse the feasibility of the operation.
• To identify the staff required -including skills and qualifications- for operating the proposed slaughter facility.
4) DURATION OF ASSIGNMENT, DUTY STATION AND EXPECTED PLACES OF TRAVEL

Duration: 10th November - 10th December 2014
Maximum working days: 20
Duty Station: Uganda for the collection of basic information, however the consultant can work from home after it.
Expected places of travel: Kampala and Masaka (Uganda)

5) FINAL PRODUCTS
1. Two designs of slaughter houses (one for 20 and another for 50 pigs per day)
2. A report discussing the feasibility for building the facility in the area allocated considering availability of energy and water, options for managing the waste in an eco-friendly manner, need for staff and equipment for operating it, and some data on costs that will help another consultant to confirm the economic feasibility of the slaughter house.
### Annex 2: Mission time table

<table>
<thead>
<tr>
<th>Date</th>
<th>Activity</th>
</tr>
</thead>
</table>
| 10.11.2014 | Departure from Kigali to Kampala  
Overnight in Capital Palace Hotel Kampala |
| 11.11.2014 | Meeting in ILRI office with Dr Danilo Pezo, Briefing on ILRI activities in Uganda, and presentation of pig value chain program  
Meeting with Mrs. Mable Kabagabu, consultant for pig hub and slaughterhouse economy  
Mr. Peter Lule, Project Assistant  
Study of documents  
Night in Africana Kampala |
| 12.11.2014 | Travel to Masaka district with Dr Danilo Pezo and Mrs. Mable Kabagabu  
Meetings as shown in attached program (participants list hereafter)  
Night in Garden Courts Hotel, Masaka |
| 13.11.2014 | continuation of meetings as shown in project in the morning  
Meeting with slaughterhouse owner /butcher Mr. Charles Sswanyana at his slaughter-slab  
Visit of slaughter slab Masaka, discussion with butchers  
Visit of butcheries of Mr. Kamulegeya Tadeo and Mr. Penkale  
Afternoon re-visit of site for slaughterhouse together with staff from land department to obtain the exact measures of the plot granted by the municipality  
Night in Garden Courts Hotel Masaka |
| 14.11.2014 | Meetings according to schedule  
Afternoon return to Kampala  
Night in Africana Hotel Kampala |
| 15.11.2014 | Work at hotel  
Night in Africana Hotel Kampala |
| 16.11.2014 | Work at Hotel  
Night in Africana Hotel Kampala |
| 17.11.2014 | Work in ILRI Office Kampala  
Meeting with Mr. Philip Borel de Biche, Managing director of Greenfield Uganda Limited on his planned slaughterhouse  
Night in Africana Hotel Kampala |
| 18.11.2014 | Work in ILRI Office Kampala  
Night in Africana Hotel Kampala |
| 19.11.2014 | Visit of Wambizzi Cooperative slaughterhouse in Kampala  
Discussion with  
Mr. Simon Lubega, manager and coordinator of slaughterhouse  
Mr. Kasule Thomas, Finance Administrator  
Visit of site of small abattoir implemented by Pig Production and Marketing Uganda LTD Company in Kampala  
Meeting with owner of the company, Mr. Christopher Mulindwa  
Work in ILRI Office Kampala  
Night in Africana Hotel Kampala |
| 20.11.2014 | Work in ILRI Office  
Return to Kigali |
| 21 to 26.11.2014 | Drafting of report, email exchanges with Mr. Pezo and Mrs. Kabagadu |
| 27.11.2014 | Presentation of first draft of report with technical annexes for discussion |
| 28.11. to 05.12 2014 | Fine tuning of document, including additional images and review according to comments received |
| 05.12.2014 | Submission of revised version |
| 05 to 10.12.2014 | Review of document according to instructions |
Annex 3: People met

### ILRI Uganda – Irish Aid Pig Projects in Masaka District
Preliminary consultative meeting

**PART (A) Consultancy work – Centralized Pig abattoir – Dr Michael Handlos**

#### DAY-1 WED 12-11-2014

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Person Name</th>
<th>Title/Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.00 a.m</td>
<td>Arrival at the District HQS, Reception at the District Production Office</td>
<td>Dr. Mayega Lawrence</td>
<td>District Veterinary Officer</td>
</tr>
</tbody>
</table>
| 10.30 – 11.30 a.m | Meet Heads of Departments, Welcome Remarks by Secretary Production & Marketing  
|                | • District Production Officer  
|                | • District Commercial Officer  
|                | • District Natural Resources Officer  
|                | • District Entomology Officer  
|                | • District Engineer  
|                | • District Population Officer  
|                | Key out puts & scope of work by consultants  
|                | (a) Masaka pig abattoir  
|                | (b) Kabonera pig Hub                                                  | Prossy Mutumba                   | District Production Officer          |
| 11.30 – 12.00 a.m | Meet the Chief Administrative Officer & the Town Clerk at the Chief Administrative Officer | Sseremba Hood                   | Assistant Chief Administrative Officer |
| 1.00pm – 2.00pm | Health Break                                                            | Hotel Management                 |                                      |
| 2.00 – 3.00 p.m. | Meet Executive of Masaka Pig Cooperative Union & Kabonera Pig Hub Implementation committee | Commercial Office Board room     |                                      |
| 3.00 – 5.00 p.m. | Site visit for the Masaka Central pig abattoir                          | Sseremba Hood (ACAO)             |                                      |

#### DAY-TWO THUR 13-11-2014

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Person Name</th>
<th>Title/Position</th>
</tr>
</thead>
</table>
| 9.00 – 11.00 a.m | Visit Local slaughter places, Traders & butchers  
|                | • Kimanya-Kyabakuzza (Ssewanyana Charles)  
|                | • Ssaza slaughter places  
|                | • Nyendo-Ssenyange                                                        | Sserwadda Joseph                 | In charge Pork inspection-Masaka Municipality |
| 11.00 – 12.40 a.m | Meet Executive committees of primary cooperatives  
|                | • Butege Pig Cooperative Society  
|                | • Kirumba-Katwe Pig Cooperative Society  
|                | • Nyendo-Ssenyange Pig Cooperative society  
|                | • Kimanya-Kyabakuzza pig cooperative society                             | PALM SPRINGS HOTEL SsAza         |                                      |
| 12.40 – 1.00 p.m. | Discussions                                                              | District Veterinary Officer      |                                      |
| 1.00pm – 3.00pm | Personal work by consultant                                              | Hotel Management                 |                                      |
### DAY-THREE FRI 14-11-2014

<table>
<thead>
<tr>
<th>Time</th>
<th>Activities</th>
<th>Personnel/Officer</th>
</tr>
</thead>
</table>
| 9.00 a.m-12.00 noon | - Meeting at the District HQS  
- Designs for the pig abattoir  
- Environmental Impact assessment  
- Disposal issues  
- Draft MoU and TOR for Ownership, Building, Operation and Management of the pig abattoir  
- Discuss implementation work plan                      | - District Veterinary Officer  
- District Engineer  
- District Natural Resources Officer  
- Sseremba Hood (Assistant Chief Administrative Officer)  
- Danilo Pezo  
- Masaka Pig Cooperative Union  
- District veterinary Officer |
| 1.00pm - 2.00 pm    | Health Break and Departure to Kampala                                                            | Hotel Management  
Hotel Brovad |

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### DAY-TWO THUR 13-11-2014

<table>
<thead>
<tr>
<th>Time</th>
<th>Activities</th>
<th>Personnel/Officer</th>
</tr>
</thead>
</table>
| 9.00 – 11.00 p.m. | Meet Executive committee of Kyanamukaka-Kabanera Pig Cooperative Society and Committee members for the pig Hub at Kabanera  
- Discuss implementation work plan  
- Draft MoU and TOR for managing the pig Hub                      | Mayanja Lawrence  
(Area Veterinary Officer)  
The Chairperson and executive Committee  
Kyanamauka-Kabanera Pig Cooperative Society  
Venue: Bukunda Primary School |
| 11.00 – 12.40 p.m. | Visit site location at Kabanera Market                                                          | Mayanja Lawrence |

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### DAY-THREE FRI 14-11-2014

<table>
<thead>
<tr>
<th>Time</th>
<th>Activities</th>
<th>Personnel/Officer</th>
</tr>
</thead>
</table>
| 9.00 a.m-12.00 noon | - Meeting Executive Committee of Kyanamukaka-Kabanera at Kabanera  
- Finalize Draft MoU and TOR for managing the pig Hub  
- Finalize implementation work plan                      | The Chairperson and executive Committee  
Kyanamauka-Kabanera Pig Cooperative Society  
Venue: Bukunda Primary School |
| 12.00-1.00    | Drive back to Masaka                                                                            |                                                 |
| 1.00pm - 2.00 pm | Health Break and Departure to Kampala                                                            | Hotel Management  
Hotel Brovad |

---

L.N. Mayega (Dr)  
District Veterinary Officer  

C.C The Chief Administrative Officer  
C.C The Town Clerk Masaka Municipality  
C.C ACAA-Sseremba Hood/ Secretary District Land Board  
C.C District Production Officer  
C.C District Natural Resources Officer  
C.C Chairpersons of Masaka pig Cooperative Union & 5 Primary Cooperative Societies
### DAY-1 WED 12-11-2014: ATTENDANCE OF DISTRICT OFFICIALS

<table>
<thead>
<tr>
<th>Name</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haj Jamil Miwanda</td>
<td>Secretary Production &amp; Marketing</td>
</tr>
<tr>
<td>Dr Mayega Lawrence</td>
<td>District Veterinary Officer</td>
</tr>
<tr>
<td>Mutumba Pross</td>
<td>District Production Officer</td>
</tr>
<tr>
<td>Nabologna Ndyahika</td>
<td>District Commercial Officer</td>
</tr>
<tr>
<td>Nakyejwe Rose</td>
<td>District Natural Resources Office</td>
</tr>
<tr>
<td>Senkaayi Godfrey</td>
<td>District Entomology Officer</td>
</tr>
<tr>
<td>Eve Luvumu</td>
<td>Animal Nutritionist</td>
</tr>
<tr>
<td>Sserwadda Joseph</td>
<td>Animal Husbandry Officer</td>
</tr>
</tbody>
</table>

### DAY-1 WED 12-11-2014: OFFICE OF THE CHIEF ADMINISTRATIVE OFFICER

<table>
<thead>
<tr>
<th>Name</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. Fredrick Ssemwogerere</td>
<td>Deputy Chief Administrative Officer</td>
</tr>
<tr>
<td>Mr. Emmanuel Mugisha</td>
<td>Assistant Town Clerk</td>
</tr>
</tbody>
</table>

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### Greater Masaka Pig Cooperative Union

#### Consultative Meeting for the Central Pig Abattoir & Pig Hub

<table>
<thead>
<tr>
<th>Name</th>
<th>Designation</th>
<th>Tel. No.</th>
<th>No. pigs on farm</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mw. Kato G. L.</td>
<td>Member</td>
<td>0772327706</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>2. Missie Samuel</td>
<td>Member</td>
<td>0752445976</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>3. N. A. H. J.</td>
<td>Member</td>
<td>0772587213</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>4. Sabiti Ivan</td>
<td>Member</td>
<td>0772555433</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>5. Barbara Kasuna</td>
<td>Member</td>
<td>0757727225</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>6. Sam Ssekyonjor</td>
<td>Member</td>
<td>0799583640</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>7. Caleb J. J. K.</td>
<td>Member</td>
<td>0784570747</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>8. Ssemwogerere Ch. L</td>
<td>Member</td>
<td>0772342473</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>9. Kabino Ndyahika</td>
<td>District O. C.</td>
<td>0755303043</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>10. Moses P.</td>
<td>Member</td>
<td>0772787738</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>11. N. M. M.</td>
<td>Member</td>
<td>0772451212</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>
Annex 4: Handling of butcher waste and dead animals

Background
In fact, the safe destruction of dead animals, of any seized, condemned or of inedible parts of an animal during slaughtering and meat processing and of expired/rotten meat products in butcheries and supermarket presents a problem for all farms, slaughterhouses, meat processing units, butchers shops, veterinary clinics and even supermarkets (in case of rotten/expired meat).

Inedible animal by-products (ABP) can be treated without health risks in composting plants and biogas digesters (e.g. blood). Whereas pathogenic material (EC refers to ABP category 1) needs special care.

With regard to animal products the Codex Alimentarius27 “CODE OF HYGIENIC PRACTICE FOR MEAT, CAC/RCP 58-2005” stipulates for slaughterhouses, but also for enterprises in which meat is processed or sold:

<table>
<thead>
<tr>
<th>Parts of animals deemed unsafe or unsuitable for human consumption should be:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• placed without delay into specifically identified chutes, containers, trolleys, or other handling facilities;</td>
</tr>
<tr>
<td>• identified by means as appropriate to the type and end use of the tissue;</td>
</tr>
<tr>
<td>• in the case of condemned material, handled in rooms reserved for that purpose and conveyed in a secure manner to a place of disposal (e.g. rendering station).</td>
</tr>
</tbody>
</table>

With regard to dead animals the rules are similar. The principles of dead stock management are:

- Dispose of the animal as soon as possible to reduce the risk of disease spreading.
- Do not leave animal carcasses in the open where dogs or other animals can get to them or where they are visible from the road.
- Never dispose of carcasses in farm dairy effluent ponds.
- Keep dead stock well away from waterways, wetlands, and bores.

A solution for the handling of dead animal and inedible or contaminated products during slaughter and processing needs to be developed which matches the existing legal framework.

Methods of disposal28
Throughout history, burial and to a lesser extent, burning, have been the most commonly applied methods for the disposal of on-farm mortalities. However the disposal by burial and burning is now widely rejected based on the perceived risk of an incomplete destruction of pathogens from mortalities during these processes, and thus the entering of infective agents into the animal feed chain.

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27 Codex Alimentarius: The Codex Alimentarius Commission, established by FAO and WHO in 1963 develops harmonized international food standards, guidelines and codes of practice to protect the health of the consumers and ensure fair practices in the food trade. Codex standards are based on the best available science assisted by independent international risk assessment bodies or ad-hoc consultations organized by FAO and WHO. While being recommendations for voluntary application by members, Codex standards serve in many cases as a basis for national legislation.

28 http://ecan.govt.nz/advice/your-business/farming/Pa8.2. Pigs died of diseases or unknown reasons shall be collected and disposed of as regulated by veterinary authorities. They shall not be marketed or thrown out in the environment ges/dead-stock-offal-disposal.aspx
The FAO manual on slaughterhouse cleaning and sanitation on the other hand suggests in chapter 2.7.8 Condemned products: “A separate lockable room or area for keeping condemned material until the end of the working day should be provided. An incinerator or a deep pit should be available for disposal of condemned material”.

Six options for the destruction are presented hereafter from the cheapest to the most expensive solution. Table 1 compares the advantages and disadvantages of each method, table 2 provides an idea of risks to human health.

**Option 1: Burial and landfills**

Shallow burial may be a convenient method of disposal where water tables are low enough to avoid groundwater contamination. Controlling vermin and scavengers can be difficult. Make sure that the hole is backfilled immediately and that the buried carcass is well covered, so that dogs or other scavengers cannot dig it up. Select an area with clay or impervious soil below to contain any leachate and site the hole at least 100 m from domestic bores or surface waterways to avoid contamination. Do not bury animals in the floodplain of a waterway.

**Digging of a pit:**

The size of the pit depends on the volume of animal waste (inedible or seized slaughter by products, cadavers, stillborn fetuses, placentas) to be buried. The volume of a burial pit must be 3-4 times larger than the volume of the waste to be buried.

**The process of burial:**
- Size of burial pits: maximum depth 1.2 m – 1.5 m, maximum width 3 m, maximum length 9 – 12 m
- Bottom of pit must be made with water tight material – in particular in sandy areas to protect the groundwater
- Spread a layer of lime powder (1 kg / 1m²) at the bottom of the pit.
- Throw the waste into the pit
- Spray disinfectant (chlorine, glutaraldehyde or lime) on the surface of the waste
- Fill the pit with soil (0.6 m) adding layers from other materials, compact the soil, cover with large stones
- Apply a layer of lime on the surface of the pit and spray disinfectant (chlorine group, iodine, or glutaraldehyde) around the burial pit
- Warning signboards must be placed on the burial site of animals and animal products.
- Ensure that no dogs or wild animals can dig up the dead corpses
**Option 2: Pyre / Burning**

Slaughter waste and/or dead animals are placed in a container or a dug ole, carefully some paraffin/kerosene/diesel is added and set to fire.

Attention: Petrol is highly flammable and can cause explosions. Petrol should not be used. Beware of smoke, burning plastic bags can be hazardous to your health.

**Option 3: Offal pits**\(^{29}\) and disposal vessels\(^{30}\)

While offal pits are considered a simple and cheap method of disposing of small quantities of dead stock and offal they require good management in order to reduce their impact on the environment.

Disadvantage: impractical to empty when full,

**Location of offal pits**

- Offal pits must be at least 50m from waterways, wetlands, bores and property boundaries.
- Areas where the water-table is high or poorly draining soils must be avoided. The bottom of the pit should be at least 3m above the top of the maximum expected groundwater level. There must be no groundwater entering the bottom of your pit. (this conditions may be difficult for many places in the lowland/coastal areas of Vietnam)
- Surface runoff must be directed away from the pit.
- Animals and rodents must be prevented from accessing the pit.
- Offal pits can only be used for waste that originate from the property they are on (one pit for one slaughterhouse only).
- Pits should not be located in areas prone to flooding or ponding due to heavy rainfall (1 in 5 year event).

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\(^{29}\) Info sheet 14/2009 from www.ecan.govt.nz

\(^{30}\) http://www.omafra.gov.on.ca/english/engineer/facts/09-027.htm
Construction

- Offal pits may be narrow trenches dug by an excavator, or vertical shafts usually about 1m in diameter and a few meters deep constructed by a large diameter auger.
- The volume of the pit should be no more than 30 cubic meters.
- The top of the pit should be covered with a heavy-duty concrete slab at least 125mm thick.
- Use lime to reduce smell and help decomposition.

Option 4: Composting

Composting provides an inexpensive alternative for disposal of all dead animals, butcher wastes and other biological residuals. The temperatures achieved during composting will kill or greatly reduce most pathogens, reducing the chance to spread diseases. Properly composted material is environmentally safe and a valuable soil amendment for growing certain crops (applying this compost to “table-top” crops directly consumed by people is not recommended). The compost should also not spread on land where animals will graze to avoid any remaining health risk.

The practice requires, however space on land to construct the compost piles and takes from two to six months for the animal products or animals to decompose. In fact, when animal carcasses or butcher waste is composted, the large bones do not completely break down. Bones from immature animals degrade very quickly, but bones from mature animals take several seasons to breakdown. After the material is composted, bones can be reused as part of the base for the next compost pile.

Composting can be undertaken in bins or open piles or windrows. Several types of bins exist made from wood, simple fencing material, concrete or plastic. Plastic composting bins may be the best solution for small scale slaughterhouses in addition to biogas digesters as they require only little space.
Location and general conditions

- Selected site must be well drained and above ground water level, at least 200 feet from water courses, sinkholes, seasonal seeps or other landscape features that indicate the area is hydrologically sensitive
- The site must be sufficient large for at least 3 piles or pins and for all operation works and easily accessible
- Bulking material: Untreated sawdust is recommended because of its small particle size and high absorbency that minimizes leachate. Straw can be used but there are problems in using it such as longer breakdown times, and leachate production. Generally a straw stack will need to be
- roofed and built on a concrete surface so that leachate can be collected.

Windrows\(^3\)/piles\(^2\)

a. In the windrow process garbage is laid in long heaps above ground and oxidation and fermentation is carried out by regular turning thereby keeping air, moisture and temperature under control till it gets stabilized
b. Windrows are generally built up to be 1.5m high and 3m wide.
c. Windrows need to be fenced to keep stock and scavengers out
d. The final pile is cone shaped, 2.4–3.6 m (8–12 ft) wide at the base and 1.2–1.8 m (4–6 ft) tall at the highest point

Bins

bin with open sides or a tumbler with aeration holes.
a. The composting bin needs to be at least 60cm wider and longer than the largest animal you will be expecting to compost.
b. Usually you will need three bins – two for composting and one being filled.
c. Permanent systems should foresee concrete bins in a covered shed
d. A lid or cover will allow to control moisture and also keep scavengers out.
e. A roof over the bins is recommended, but is not necessary if a tarp can be used during periods of excessive rainfall

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\(^1\) http://www.omafra.gov.on.ca/english/engineer/facts/09-017.htm
\(^2\) http://cwmi.css.cornell.edu/spaceittakes.pdf
Building the Pile
a. Place at least 60cm of bulking agent on the ground or floor of the composting bin.
b. Place the animal products to be composted in a single layer on top of the bulking agent, at least 30cm from the edge of the pile and at least 30cm apart. Split the stomach of each carcass as it is added.
c. Cover the material with 60cm of bulking agent.
d. Add water if needed – the pile should leave your hand feeling moist, but you should not be able to squeeze any water out of it.
e. Once the pile is full, start a second pile following these same steps

Trouble shooting

<table>
<thead>
<tr>
<th>Issue</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low temperature</td>
<td>Adjust pile moisture content</td>
</tr>
<tr>
<td>Odour</td>
<td>Compost to wet, add carbon source material</td>
</tr>
<tr>
<td>Leachate</td>
<td>Base layer too thin or compost very wet</td>
</tr>
<tr>
<td></td>
<td>Reconstruct pile</td>
</tr>
<tr>
<td>Failure to decompose</td>
<td>Improper C-N ratio</td>
</tr>
<tr>
<td></td>
<td>Add carbon source material</td>
</tr>
<tr>
<td></td>
<td>Ensure proper pile construction</td>
</tr>
<tr>
<td>Insects, fly larvae</td>
<td>Insufficient cover layer or leaching of liquids</td>
</tr>
<tr>
<td></td>
<td>Add carbon source material</td>
</tr>
<tr>
<td></td>
<td>Ensure proper pile construction</td>
</tr>
<tr>
<td>Scavengers</td>
<td>Add additional mesh wire around compost to prevent animals from entering</td>
</tr>
</tbody>
</table>
Option 5: Incineration

Advantages:
- Different models are available even for very small quantities of waste (e.g. 50 kg per hour)
- Batch operation
- Animal waste can be treated on site – no transport (unless the incinerator is used for several slaughter points)
- Reduced consumption of fossil fuels (diesel of 4/6 liters per hour, gas)
- Small amount of residues (about 2% ash when burning pig by products)
- Waste to energy process producing steam and hot water which can be used in the slaughterhouse
- Reduction of costs and reduction in dependence on traditional channels (when rendering services are used)
- Odour destruction

Additional advantage: Incinerators can be used for the destruction of pathogenic hospital waste. In many countries, veterinary services and hospital services use the same incinerator (often built during the refurbishing or construction of hospital premises). As the incinerator for slaughter waste may only be used in batch processing additional capacities for hospitals or dispensaries are available.

Option 6: Rendering

Rendering is for the disposal of animal waste products is the oldest recycling methods. It involves the conversion of animal carcass/waste materials into three end products, carcass meal (meat and bone meal), melted fat/tallow, and water.

This is conducted using
- mechanical processes including grinding, mixing, pressing, decanting and separating,
- thermal processes including cooking, evaporating, and drying, as well as chemical processes such as solvent extraction. The rendering process simultaneously dries the material and separates the fat from the bone and protein. The fat obtained can be used as low-cost raw material in making grease, animal feed, soap, candles and biodiesel, and tallow is an important raw material in the steel rolling industry providing the required lubrication for compressing steel sheets. The protein meal produced can be used for animal feed. Thus the products provide significant additional income to the slaughterhouse. However, because of the problems with
BSE, the feeding of meat and bone meal to cattle is currently prohibited in developed countries. Thus rendering plants do not play as significant a role in the disposal of animal wastes today as they did in the past.

Graph 1: Rendering

As Vietnam is BSE free the use of meat and bone meal (mbm) is authorized in animal feeding reducing the use of more Soybean meal which is expensive and more environmental damaging as large areas of forest were sacrificed in Brazil for example to plan soybean for animal feeding.
<table>
<thead>
<tr>
<th>Disposal options</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-site rendering</td>
<td>Unlikely to have adverse effects on the environment</td>
<td>Only available in some areas</td>
</tr>
<tr>
<td></td>
<td>No risk of contamination from carcasses/seized products</td>
<td>Requires an area for secure storing of carcasses before pick-up</td>
</tr>
<tr>
<td></td>
<td>The use of meat and bone meal in feed rations is not prohibited in Vietnam</td>
<td>Costly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No small scale solution (minimum size of rendering units is 1000 kg)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The use of the final product (meat and bone meal (mbm) is prohibited in many countries like Vietnam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Problem of process waste water cleaning</td>
</tr>
<tr>
<td>Composting</td>
<td>Useful product generated</td>
<td>A reliable supply of carbon source (e.g. sawdust) is required</td>
</tr>
<tr>
<td></td>
<td>Reuses other farm resources such as calf-shed sawdust</td>
<td>Requires understanding of composting</td>
</tr>
<tr>
<td></td>
<td>High composting temperature destroys pathogens and prevents fly incubation</td>
<td>Predator and vermin control can be challenging</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Finished compost must not be spread on pasture grazed by stock</td>
</tr>
<tr>
<td>Offal pits</td>
<td>Simple</td>
<td>Seepage can contaminate groundwater</td>
</tr>
<tr>
<td></td>
<td>Cost effective</td>
<td>Predator and vermin control is required</td>
</tr>
<tr>
<td></td>
<td>Easy to manage</td>
<td>Increasing restrictions on use</td>
</tr>
<tr>
<td>Burial</td>
<td>Simple</td>
<td>Requires vermin control</td>
</tr>
<tr>
<td></td>
<td>Cost-effective</td>
<td>labour intensive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can contaminate groundwater</td>
</tr>
<tr>
<td>Incineration</td>
<td>Animal waste products and entire animals are destroyed quickly</td>
<td>May cause odour and smoke nuisance (if no filters are used)</td>
</tr>
<tr>
<td></td>
<td>Any pathogens present are destroyed</td>
<td>Transport and cremation costs are incurred for off-site incineration</td>
</tr>
<tr>
<td></td>
<td>It is possible that a part of the energy used for incineration can be recovered to produce e.g. hot water</td>
<td></td>
</tr>
</tbody>
</table>

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### Table: Exposure of humans to hazards from each option

<table>
<thead>
<tr>
<th>Disease/Hazardous Agent</th>
<th>Rendering</th>
<th>Incineration</th>
<th>Landfill</th>
<th>Pyre</th>
<th>Burial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campylobacter, E. Coli, Listeria, Salmonella, Bacillus anthracis, C. botulinum, Leptospira, Mycobacterium tuberculosis var bovis, Yersinia</td>
<td>Very small</td>
<td>Very small</td>
<td>Moderate</td>
<td>Very small</td>
<td>High</td>
</tr>
<tr>
<td>Cryptosporidium, Giardia</td>
<td>Very small</td>
<td>Very small</td>
<td>Moderate</td>
<td>Very small</td>
<td>High</td>
</tr>
<tr>
<td>Clostridium tetani</td>
<td>Very small</td>
<td>Very small</td>
<td>Moderate</td>
<td>Very small</td>
<td>High</td>
</tr>
<tr>
<td>Prions for BSE, scrapie</td>
<td>Moderate</td>
<td>Very small</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Methane, CO₂</td>
<td>Very small</td>
<td>Very small</td>
<td>Moderate</td>
<td>Very small</td>
<td>High</td>
</tr>
<tr>
<td>Fuel-specific chemicals, metal salts</td>
<td>Very small</td>
<td>Very small</td>
<td>Very small</td>
<td>High</td>
<td>Very small</td>
</tr>
<tr>
<td>Particulates, SO₂, NO₂, nitrous particles</td>
<td>Very small</td>
<td>Moderate</td>
<td>Very small</td>
<td>High</td>
<td>Very small</td>
</tr>
<tr>
<td>PAHs, dioxins</td>
<td>Very small</td>
<td>Moderate</td>
<td>Very small</td>
<td>High</td>
<td>Very small</td>
</tr>
<tr>
<td>Disinfectants, detergents</td>
<td>Very small</td>
<td>Very small</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Hydrogen sulfide</td>
<td>Very small</td>
<td>Very small</td>
<td>Moderate</td>
<td>Very small</td>
<td>High</td>
</tr>
<tr>
<td>Radiation</td>
<td>Very small</td>
<td>Moderate</td>
<td>Very small</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

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### Conclusion and recommendations

A safe meat value chain from farmer to consumer requires that all hazards along the chain are mastered

- Farm level: healthy, well balanced feed free from antibiotics and hormones, limited use of approved antibiotics, solid and liquid waste treatment, animal identity for traceability of animals to their origin, health certificates when moving animals
- Transport of animals to the slaughterhouse in vehicles which are water tight to avoid leakages of animal feces and urine on the street,
• Slaughtering in refurbished/newly constructed slaughterhouses meeting legal requirements with sanitary installations for workers, fresh, clean water, ante mortem inspection, post mortem (meat) inspection, animal identification during the slaughter process, control of hygiene in the slaughterhouses (application of HACCP, GMP, control) including health status of staff, handling of liquid and solid waste, management of seized, condemned or inedible parts of the animal
• Transport of meat in a hygienic manner from slaughterhouse to market (closed containers which can be easily and efficiently cleaned)
• Hygienic handling of meat in refurbished or newly constructed hygienic meat markets, food inspection, health status of meat vendors, sanitary installations, fresh water, handling of liquid and solid waste

In order to fulfill the requirements of GMP/GHP/HACCP practices (see Codex Alimentarius before) all slaughterhouses and slaughter points must be equipped with watertight bins in which seized material is deposited during the slaughter hours before being disposed. These products are best decontaminated on site. However, as only small quantities of inedible ABP are produced during the slaughter process, in particular the small scale slaughterhouses the best solution is composting. For the small scale slaughterhouses the bin composting technique combined with biogas digesters is probably the cheapest and most practical solution.

Even for larger slaughterhouses the purchase of an incinerator will be a huge financial burden, whereas composting may require too much land.

In order to destroy larger quantities of inedible ABP and to handle – if necessary – pathogenic material (seized ABP or dead animals) the purchase of small incinerators managed by the veterinary services should be considered as incineration reduces significantly the risk of diseases. However incineration does not generate any revenues (like a rendering plant would), but entails rather the costs of operation (mainly fuel costs) which need to be covered either by the public budget or recovered from the users e.g. slaughterhouse operators through a quantity based fee collection.

To justify the investment of district incinerators the option to share this installation with the public health services should be assessed. Incinerators are able to decontaminate also pathological waste from hospitals and dispensaries and may fill gaps of disposal of these products at district level. A joint management of incinerators by veterinary and public health services may reduce the operating costs.
## Annex 5: Slaughter line equipment and construction details

### Gambrel rail

<table>
<thead>
<tr>
<th><strong>Figure 1:</strong> Height for rails of slaughter line of pigs</th>
<th><strong>Figure 2:</strong> Round bar overhead rail for pigs (measurements in millimetres)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Figure 1" /></td>
<td><img src="image2.png" alt="Figure 2" /></td>
</tr>
<tr>
<td><strong>Figure 3:</strong> Hook with chain for pigs</td>
<td><strong>Figure 4:</strong> Hook with gambrel for pigs (hooks must be made from stainless steel)</td>
</tr>
<tr>
<td><img src="image3.png" alt="Figure 3" /></td>
<td><img src="image4.png" alt="Figure 4" /></td>
</tr>
</tbody>
</table>
Figure 5: Hook with meat hook

Figure 6: Viscera cart
A for red offal: liver, lung, heart, kidneys
B for green offal like intestine, stomach, etc

Figure 7: Restrainer for blood collection, dehairing table, viscera cart

Figure 8: Cutting table
<table>
<thead>
<tr>
<th>Figure 9: Butcher knifes, axes, choppers</th>
<th>Figure 10: Pressure cleaner</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Butcher knifes, axes, choppers" /></td>
<td><img src="image2" alt="Pressure cleaner" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Figure 11: Locally made stunning pliers</th>
<th>Figure 12: Imported captive bolt stunner</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3" alt="Locally made stunning pliers" /></td>
<td><img src="image4" alt="Imported captive bolt stunner" /></td>
</tr>
</tbody>
</table>
Figure 13: Scale

Figure 14: Mechanical dehairing machine
Annex 6: Stunning

Most countries have legislation requiring that animals are rendered unconscious (stunned) by a humane method prior to bleeding. Exceptions are made for religions which require that ritual slaughter without prior stunning is practiced, provided the slaughter method is humane (which is easier for sheep and goats than for pigs). Stunning also makes sticking (throat-slitting) less hazardous for the operator. The animal must be unconscious long enough for sticking to be carried out, and for brain death to result from the lack of blood supply. It is however very important that slaughter animals should be properly restrained before stunning or bleeding. This is to ensure stability of the animal so that the stunning operation can be carried out accurately and properly.

The question is: which method can be applied by small slaughterhouses under LIFSAP funding considering among other things the cost of efficient stunning devices.

There exist 4 ways of stunning:
1. Simple stunning equipment for direct blow (hammer see image 1 below) as it is practiced in many small slaughterhouses in Vietnam (and elsewhere in the world)
2. Stunning gun (captive penetrating bolt stunner) powered by either compressed air or a blank cartridge (Image 2). Price around 600US$ for a cartridge stunner
3. Electrical head tongs (Image 3) Imported models up to 3000 US$ but local made tongs exist at a lower price
4. Carbon dioxide gas stunning (reserved for large slaughterhouses)

Advantages/inconveniences of the methods

1) Traditional method
Now cost involved. Most slaughter-men are familiar with the technique. A blow with the hammer is certainly preferable to no pre-stunning, but it requires a skilled operator. However very often additional blows are needed, if the animal was not hit properly. Particular malpractice can be observed in pig slaughter, when a number of pigs are driven into a stunning pen and indiscriminately treated with hammer blows. Because they move around, many animals are not hit efficiently; they need additional blows or arrive fully conscious at bleeding.

2) Stunner (stunning (bolt ) guns):
the penetrating bolt destroys the brain precluding the use of brains for human consumption. The guns require maintenance. Animals must be restraint. The use of stunning guns requires experience and skill of the slaughterman.

3) Electric stunning tongs
Electric stunning is often blamed for meat quality issues like DFD (dark firm, dry meat) or PSE (pale, soft, and exudative meat) This mainly occurs if the devices are technically not correct (see table 1 below on technical details)
<table>
<thead>
<tr>
<th>1</th>
<th>Traditional stunning with hammer</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 a</td>
<td>Stunner using blank cartridges</td>
</tr>
<tr>
<td>2 b</td>
<td>Stunner using compressed air</td>
</tr>
</tbody>
</table>

- 1: Traditional stunning with hammer
- 2a: Stunner using blank cartridges
- 2b: Stunner using compressed air

Electrical Scissor shaped stunning tongs
**Correct application:**

<table>
<thead>
<tr>
<th>Image 1</th>
<th>Image 2</th>
<th>Image 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="" /></td>
<td><img src="image2.png" alt="" /></td>
<td><img src="image3.png" alt="" /></td>
</tr>
</tbody>
</table>

Use of a hammer, or back of an axe, etc. Significant skill and strength are required to ensure that the blow to the head is carried out effectively. Misadventures may arise due to movement of the head and, therefore, some form of firm restraint should be used.

The penetrating type of captive bolt pistol (CBP) produces immediate insensibility by destruction of the cortex and deeper parts of the brain. The important factor in producing unconsciousness is the actual velocity of the bolt and the speed at which it strikes the brain rather than the penetration of the brain. The most common cause of low captive bolt stunning efficacy was poor gun maintenance.

Stunning with electricity is known as electro-narcosis, and killing with electricity is known as electrocution. Electro-narcosis is a fully reversible procedure, immediately disrupting normal brain function for a short period.
Annex 7: Monorail basic slaughterhouse for 20-25 pigs per day

Floorplans for a mono rail pig slaughterhouse
Figure 1 shows the floorplan, Figure 2 the plan of the drainage system, Figures 3, 4, and 5 des variants

Figure 1: Floorplan of a pig mono rail slaughterhouse and waste water drainage (either separate drainage for dirty and clean area, or drainage from clean to dirty zone) (in cm)
Clean zone

Dirty zone

1. Pig Pens
2. Cloakroom and lavatories
3. Boiler room
4. Stuning and bleeding area
5. Hoist
6. Rail
7. Scalding
8. Tilling rail
9. Condemned material
10. Offall room
11. Slaughtering rail
12. Evisceration, carcass splitting post mortem inspection, weighing
13. Scale
Figure 2: Details of slaughter area (extract from figure 1)
Figure 3: An alternative construction plans
Figure 4: Perspective floor-plan pig slaughterhouse for 20-25 pigs/day

Figure 5: Rectangular floor plan for a slaughterhouse for 20-25 pigs/day