

**NIRDA**

National Industrial  
Research and Development  
Agency

NATIONAL INDUSTRIAL RESEARCH AND DEVELOPMENT AGENCY

# **TECHNOLOGY AUDIT FOR THE PIGGERY VALUE CHAIN REPORT**

September 2020

## **EXECUTIVE SUMMARY**

The 2020 Technology Audit of the Piggery Value Chain was an initiative of the Government of Rwanda (GoR) through the National Industrial Research and Development Authority (NIRDA) and the Rwanda Agriculture Board (RAB). Funding for this study was provided by ENABEL, the Belgian Development Agency.

This study was conceptualised in the contextual background of the GoR's efforts to transform the agricultural sector to make it market-driven, linked to urbanization and trade with increased productivity as envisaged in Rwanda's Vision 2050 blueprint. To achieve increased incomes, high-quality livelihoods and modern living standards to all citizens, the policy identifies the need to make long-term investment decisions with future endowment as well as leverage on the surplus low-skilled labour. This is in the backdrop of a projected rise in Rwanda's population by more than 50% to 17.6 million by 2035 and to double to about 22.1 million people by 2050.

The first phase of the National Strategy for Transformation (2017-2024) was developed as part of the delivery process of Vision 2050. The focus of its economic pillar was to create 1.5 million decent and productive jobs, modernise and increase productivity of agriculture and livestock and to promote sustainable management of the environment while mainstreaming gender and social inclusion. The objective was to promote industrialization through identifying and expanding industries in the private sector, identifying priority value chains, anchor firms with market linkages, value addition of agriculture products, strengthening value chains and encouraging private sector investment in post-harvest handling technology. It was in this light that MINAGRI considered the piggery value chain for improvement.

According to the Rwanda livestock master plan (LMP,2017), the pork value chain's development road map 2017/2018 – 2021/2022 overall target under the recommended level of investment was to raise pig meat production from 19,945 tonnes in 2016/17 to 67,076 tonnes by 2021/22. To achieve this, investment in technology along the entire value chain will be critical. The objective of this study therefore was to establish the current available technology and technological capability in the piggery value chain in Rwanda and the potential for upgrading, extending and optimizing technology use.

The study was conducted countrywide using a mixed methods approach to meet the objectives. Primary data was collected from 332 pig farmers with 19 key informants, 12 focussed group discussions involving 87 participants, 21 pork and pork product traders and 63 consumers. Secondary data sources entailed extraction of official government documents, private sector reports and other relevant documents. Data were analysed using qualitative and quantitative methods. An ex-ante bio-economic model was used to evaluate the biological and economic aspects of pig farming enterprises in Rwanda. The study provides a comprehensive technology audit report with *policy and strategy recommendations for improving competitiveness as well as interventions by relevant government departments*.

**i. Technology gaps with potential for upgrading, extending and optimization**

***a) Technology gaps identified at production included:***

- Production systems are mainly the indigenous family pig system in either intensive, semi-intensive or extensive systems with need for better housing to improve pig comfort, improve efficiency of resource use and optimise on disease control
- Record keeping was not done at all in over 40% of pig enterprises
- Pig breeding is currently characterised by high levels of inbreeding and lack of a structured system of breed improvement resulting in unfavourable bio-economic indicators (age at first farrowing, farrowing interval, litter size, pre-weaning mortality)
- Use of artificial insemination in breed improvement is limited to the Northern Province near semen production centres in Rulindo district-Kisaro centre and Musanze district-Busogo centre, at the University of Rwanda
- Control of internal and external parasites and administration of iron injection to piglets were carried out by about 50% of producers indicating a gap in disease control
- There was wide use of non-conventional feedstuff to feed pigs. These included by-products of grain milling (85.3%), green fodder (83.1%), home-made feeds (63.8%), institutional swill (62.6%) and post-harvest farm residue (60.7%), most of which are low value in terms of meeting the nutrient requirements of pigs
- 92.2% of farmers obtained extension information from other farmers which was associated with ease of access compared to government extension services

A combination of these gaps resulted in poor productivity in pig enterprises due to low fertility, high mortality and low production potential of existing breeds; despite a favourable gross margin of 34%.

***b) Technological gaps at marketing and transport included***

- 81% of producers sold pigs to live pig markets via intermediaries while only 10.2% sold to processors including slaughter slab owners
- 58% of traders transported pigs on foot; there was limited vehicle transport

***c) Technological gaps at slaughter and processing***

- Only 2 licenced pig slaughterhouses with HACCP certification
- Limited technical and human resource capacity for processed pork products
- 70% of pork in butcheries from home slaughter with no inspection
- 100% of slaughter in slabs performed on floor, traditional stunning by heavy blow on head
- 100% of slaughter slabs –use machetes to portion pork and cut bones
- Lack of chilling or freezing facilities
- Inhumane slaughter
- Lack of proper waste disposal systems

***d) Technological gaps at consumption***

- 16.9% of consumers dislike pork due to poor quality
- Low processed product knowledge among consumers with sausage and bacon being most preferred
- No special meat cuts in butcheries

**ii) Proposed interventions to upgrade, extend and optimise technology**

***a) At production***

**1. Upgrading to intensive systems with the objective of increasing total annual pork production to 67 metric tonnes through:**

- Specialised piglet multiplication centres to produce piglets for commercial fattening centres as well as for sale to other producers/farmers
- Establishment and expansion of piglet fattening centres for supply of mature pigs for the pork market
- Expanding livestock advisory services on pig reproduction, housing, feeding, recording and general management practices. This can be achieved through extension methods such as farmer-to-farmer approach, farmer field schools and functional literacy programmes
- Establishment of a centre of excellence for building capacity in pig breeding and production management, promotion and up scaling of promising technologies, research, incubation and dissemination of technologies and building linkages with other value chain actors
- Reproductive management technology to optimise piglet production
- Piggery business hubs to aggregate producers in cohorts with the common interest of providing training, increasing access to inputs, availing credit services and coordinating marketing.

## **2. Genetic improvement through:**

- Establishing and rolling out a national pig breeding programme and a national herd registration programme
- Importing boars
- Increasing access to artificial insemination services by linking provincial centres district studs, training of farmers and inseminators, establishing pig farmers clusters of to aid in AI planning and promoting private sector participation in AI service provision.

To meet the anticipated demand for boar semen of approximately 207,918 doses annually while remaining profitable, there will be a need to upscale production by having 3 studs each hosting 60 – 70 boars.

### ***b) At transport***

-Enforcement of transport licencing stipulating:

- Appropriate vehicles that ensure animal comfort
- Origin and destination of pigs

- Appropriate time for transport

***b) At slaughter and processing***

Existing and licensed slaughterhouses need to be upgraded by providing technical assistance including;

- Capacity building in meat processing,
- Architectural designs for abattoirs,
- Machinery and equipment for quality checks and traceability. Such equipment would include: stunning equipment (electric), hoist (manual or electric), scalding vat and dehairing machine, scrapping/ gambrelling table (stainless steel), electric splitting saw and breastbone saw.
- Use of bio digesters would be an innovative approach in managing waste.
- Cold chain technology

***c) At consumption***

To increase access to a variety of wholesome, presentable and competitive products to the consumer and to increase sales volumes for vendors, technological intervention shall focus on;

- Increasing the product range to diversify consumer choice
- Creating product knowledge through advertising campaigns
- Quality assurance through formalising retail pork trade, licencing and enforcement and hygiene
- Meat storage technology such as freezers and cold-rooms
- Innovative packaging and product presentation
- Product branding
- Market segmentation

**iii) Projected annual outcomes of upgrading, extending and optimising technology**

- 7240 smallholder enterprises upgraded to modern intensive system
- 48.2% increase in live pig sold for the pork market with a value of USD 14,328,904
- 10% increase in value of processed products with a value of USD 3,729,385

- A 13-fold increase in pre-formulated feed production with a value of USD54,355,319
- Increase in income from formal on-farm employment with a value of USD 1,127,774
- 50% increase in employment (private and public) in the animal health service sector with a value of USD 702,425
- 400 direct jobs in animal feed processing

#### **iv) Recommendations**

This section provides a summary of recommendations from the Technology audit of the piggery Value Chain.

#### **a) Recommendations for policy**

##### ***1. Strengthening the enabling environment through;***

- Coordination of animal health services offered by the public and private sector to ensure synergy in disease control efforts
- Strengthening the national disease control programme for all livestock with particular consideration of highly infectious and zoonotic diseases like African swine fever (ASF) and Swine cysticercosis.
- Encourage continuous professional development among livestock healthcare workers to build their capacity in disease identification and management.
- Strengthening knowledge management and transfer through facilitating establishment of farmer field schools and functional literacy programmes
- Strict enforcement of quarantine measures
- Enforcement of fair-trade practices to limit exploitation of producers
- Formalisation of pig markets by ensuring trade contracts are honoured
- Mainstreaming gender and youth inclusivity for example through;
  - Improving access to microfinance to women through creation of a Women development fund that can be a source of credit;
  - Promoting parallel technologies that benefit women such as biogas
  - Empowerment through trainings in local women and youth groups,
  - Design funding proposals that favour access by women and youth,
  - Set requirements for training such that women and youth are not left out

- Mainstreaming youth and employment in agri-food chains through;
  - Institutionalising innovation platforms
  - Promoting the use of IT to develop solutions to challenges in the value chain
  - Advocacy for inclusion of youth in employment policy
  - Youth involvement in technical training programmes such as AI, feed processing and meat technology
- Mainstreaming sustainable environmental management and climate change through enforcing
  - Requirement for an environmental audit in all investments.
  - Promotion of climate smart technologies that reduce emission of greenhouse gases (GHG)
- Mainstreaming decent work agenda as per the United Nations Sustainable Development Goal No.8

## **2. *Recommendation for Government investment***

- a) Technical and human resource capacity in quality evaluation of meat and processed meat products, animal feeds and feed additives and traceability systems as a catalyst for investment
- b) Public-Private Partnerships in investments that require large capital outlays and those that are often less profitable including;
  - Establishment of large volume export slaughterhouses
  - Establishment of breeding centres, centre of excellence and district studs
  - Infectious disease control and surveillance;
  - Market intelligence/ survey;
  - Establishment of a national livestock breeding strategy
  - Inspection of compliance to market standards and certification
- c) Through NIRDA's support

### **b) Recommendations for investment and technical support**

#### **1. NIRDA – through use of open calls NIRDA could invest through;**

- Logistical and technical support in acquisition of relevant technologies in pig production, processing, marketing and consumption

- Capacity building through acquisition of technical capacity or strengthening existing capacity.

Support to private sector investment could be directed towards

- Pig breeding centres for breeding pigs and artificial insemination
- Piglet multiplication centres
- Piglet fattening/ finishing establishments
- Pig slaughtering facilities for export grade pork
- Pork processing facilities for production of high value products
- Logistics
- Animal health and animal input supply

## 2. Business support services that NIRDA can provide

Infrastructural support to enterprises should go together with capacity building in soft skills to ensure a holistic approach to business support. The following are areas where NIRDA can provide training to so as to optimise management efficiency;

- Development of business/ investment plan
- Basic business accounting
- Business finance
- Marketing
- Business/ livestock insurance
- Quality standards and quality certification

### **d) Recommendations for further research**

This study recommends the following for further research;

1. Potential for local production of semen extenders with the aim of reducing the cost of AI
2. The potential of using indigenous breeds of pigs in development of a breed adapted for the local environment
3. Nutrient and feeding values of various locally available feed resources to establish potential benefits

-Innovation of value-added pork products that could be patented

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## **LIST OF ABBREVIATIONS AND ACRONYMS**

ADG	Average daily gain
AHS	Agricultural Household Survey
ASF	African swine fever
CPPA	Centre de Perfectionnement et de Promotion Agricole
CSP	Commercial specialized piglet fattening system
DPMS	Digital Pig Management Systems
DRC	Democratic Republic of Congo
EICV	Enquête Intégrale sur les Conditions de Vie des ménages (English acronym IHLCS)
EOWE	Enhancing Opportunities for Womens' Enterprise Programme
ESIA	Environmental and Social Impact Assessment
ESMP	Environment and Social Management Plan
FAO	Food and Agriculture Organisation of the United Nations
FFS	Farmer Field Schools
FGD	Focus Group Discussion
FMD	Foot and mouth disease
GDP	Gross Domestic Product
GIS	Geographic Information System
GMP	Good Manufacture Practice
GnRH	Gonadotropin releasing hormone
GoR	Government of Rwanda
HACCP	Hazard Analysis Critical Control Points
ICT	Information Communication Technology
ICT4Ag	Information Communication Technology for Agriculture
IFP	Improved Family mixed Pig system
ILRI	International Livestock Research Institute
ISO	International Organization for Standardization
KII	Key Informant Interviews
LMP	Livestock Master Plan
MINAGRI	Ministry of Agriculture and Animal Resources

MINICOM	Ministry of Trade and Industry
MINECOFIN	Ministry of Finance and Economic Planning
MT	Metric tonnes
NAEB	National Agricultural Export Board
NAP	National Agricultural Plan
NGOs	Non- Governmental Organisations
NIRDA	National Industrial Research and Development Agency
NISR	National Institute of Statistics of Rwanda
NST	National Strategy for Transformation
ODK	Open Data Kit
OIE	Office International des Epizooties
PGF2 $\alpha$	Prostaglandin F2 $\alpha$
PPP	Public Private Partnership
PSF	Private Sector Federation
PSTA	Plan Stratégique pour la Transformation de l’Agriculture
PVC	Piggery value chain
RAB	Rwanda Agricultural and Animal Resources Development Board
R-LSA	Rwanda Livestock Sector Analysis
PSTA 4	Plan Stratégique pour la Transformation de l’Agriculture 2018- 2024
PSU	Primary Sampling Unity
RCVD	Rwanda Council of Veterinary Doctors
RDB	Rwanda Development Board
FDA	Food and Drug Authority
R-PFA	Rwanda Pig Farmers Association
RWF	Rwandan Francs
SDGs	Sustainable Development Goals
SNV	Netherlands Development Organisation
SOP	Standard Operating Procedure
SSA	Sub-Saharan Africa
UR-CAVM	College of Agriculture and Veterinary Medicine, University of Rwanda
UNICEF	United Nations International Children Emergency Fund

# CHAPTER ONE

## INTRODUCTION

### 1.0 General introduction

Over the last decade, Rwanda's economy has remained on a strong growth path and has almost tripled its per capita gross domestic product (GDP). Rwanda's economy has maintained the steadiest growth in Sub-Saharan Africa (SSA) with an average of 9 – 10% annually<sup>1</sup>. This growth has been associated with revitalised agricultural sector leading to improved export earnings. The agriculture sector employs 80% of the active population. In 2019, agriculture contributed 24% to the country's GDP. The Government has allocated 13% of the National budget to boost productivity and ensure food security and as a result, there has been a gradual shift from subsistence to a market-oriented production. Poverty levels in Rwanda have significantly reduced from 57% in 2005/2006 to 39% in 2017 with increased literacy rate of 71% for persons above 15 years of age.

Faced with emerging challenges associated with a growing population and the increasing need for higher incomes, high-quality of living with better living standards, the Government of Rwanda enacted Rwanda Vision 2050<sup>2</sup>. This policy has been operationalized through other subsidiary legislation. The National Strategy for Transformation 2017- 2024 (NST-1)<sup>3</sup> in its economic pillar aims at creating 1.5 million decent and productive jobs, modernizing and increasing productivity of agriculture and livestock and promoting sustainable management of the environment. Together with the Made in Rwanda Policy<sup>4</sup>, the policy aims at identifying and expanding industries in the private sector, identifying priority value chains, anchor firms with market linkages, value addition of agriculture products, strengthening commercialization of value chains and enhancing private sector investment in post-harvest handling technology.

Over the past two decades, various livestock development policies and initiatives have been developed aimed at promoting and enhancing livestock production and productivity that are market oriented for progressive smallholder livestock farmers. To accelerate transformation in agriculture, the Ministry of Agriculture and Animal Resources (MINAGRI) has prepared a

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<sup>1</sup> National Institute of Statistics of Rwanda, 2019. <http://www.statistics.gov.rw>

<sup>2</sup> Republic of Rwanda, Rwanda Vision 2050, June 2018.

<sup>3</sup> Republic of Rwanda, National Strategy for Transformation (NST 1) 2017 – 2024.

<sup>4</sup> Republic of Rwanda. Made in Rwanda Policy, November 2017

fourth Strategic Plan Agricultural Transformation (PSTA 4)<sup>5</sup>. This plan has been developed in line with Rwanda's Vision 2050 and the National Strategy for Transformation (NST1), which are the overarching long and medium-term national planning documents.

Successful implementation of the PSTA 4 requires collaboration between stakeholders, alignment of programs and investments, as well as mutual review and accountability mechanisms. According to National Agriculture Plan (NAP), agricultural production is expected to increase accordingly in order to meet socio-economic and food and nutrition security demand. This initiative supports smallholder farmers and is aiming at shifting production towards higher-value products.

This study is therefore anchored in the core objectives of Rwanda's vision 2050 which seeks to transform agriculture from its current subsistence form to a market driven entity with increased productivity and competitiveness. This policy anticipates achieving these goals by promoting the use of technological innovations, extension, research and development, supporting private sector investment in agricultural value chains and creation of niche markets. An important outcome will be the creation of many decent and productive jobs in agricultural value chains thereby raising incomes and improving the quality of life of Rwandans.

Furthermore, the Government of Rwanda through the National Industrial Research and Development Agency (NIRDA) aims at achieving positive results across the industrial sector through improving competitiveness of existing industries and identifying new sub-sectors or value chains where investment by the private sector would lead to export growth and import substitution. Provision of incentives to producers to improve production of quality products and enhancement of competitiveness of Rwandan small and medium sized enterprises are also enacted in the Rwanda Consumer and competition protection policy<sup>6</sup>. In line with the United Nations resolutions on the Sustainable Development Goals (SDGs)<sup>7</sup> the government through MINAGRI embarked on creation of sustainable, decent and inclusive employment opportunities by developing a strategic plan for agriculture transformation in June 2018. The four priority

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<sup>5</sup> Republic of Rwanda, Strategic Plan for Agricultural Transformation  
<http://www.amis.minagri.gov.rw/documents/strategic-plan-agricultural-transformation>

<sup>6</sup> Rwanda Consumer and Competition Policy, 2010. MINICOM

<sup>7</sup> United Nations General Assembly, Transforming our world : the 2030 Agenda for Sustainable Development, 21<sup>st</sup> October 2015 <https://www.refworld.org/publisher/UNGA.html>

areas of the strategic plan included; (i) Innovation and extension, (ii) Productivity and resilience, (iii) Inclusive markets and value addition and (iv) Creation of an enabling environment and responsive institutions.

### **1.1 Background and context**

The 2020 Technology Audit of the Piggery Value is an initiative of the Government of Rwanda through its departments that include the Ministry of Agriculture and Animal Resources (MINAGRI), the Rwanda Agriculture Board (RAB) and the National Industrial Research and Development Authority (NIRDA). Funding for this study was provided by ENABEL, the Belgian Development Agency.

This study was conceptualised in the contextual background of the GOR's efforts to transform the agricultural sector to make it market-driven, linked to urbanization and trade with increased productivity. The need for a transition from a foreign aid and public investment-led growth model to one in which the private sector takes a lead role is envisaged in Rwanda's Vision 2050<sup>2</sup> blueprint. To achieve increased incomes, high-quality livelihoods, and modern living standards to all citizens, the policy identifies the need to make long term investment decisions with future endowment as well as leverage on the surplus low-skilled labour. This is in the backdrop of a projected rise in Rwanda's population by more than 50% to 17.6 million by 2035 and to double to about 22.1 million people by 2050.

The National Strategy for Transformation (2017-2024)<sup>3</sup> was developed as part of the delivery process of Vision 2050. The focus of its economic pillar was to create 1.5m decent and productive jobs, modernise and increase productivity of agriculture and livestock and to promote sustainable management of the environment while mainstreaming gender and social inclusion. The objective was to promote industrialization through identifying and expanding industries in the private sector, identifying priority value chains, anchor firms with market linkages, value addition of agriculture products, strengthening value chains and encouraging private sector investment in post-harvest handling technology. It was in this light that MINAGRI identified the piggery value chain for improvement.

Technology and innovations are key in impacting on performance indicators. These technologies include those that enhance general management, reproductive and growth efficiencies, carcass quality, marketing and logistics as shown in Table 1.

**Table 1 Technological interventions in the pig value chain and their effects on performance**

<b>Function</b>	<b>Conventional practice</b>	<b>Technological intervention</b>	<b>Effects</b>
Breeding	Pen mating	Artificial insemination	-Increased genetic progress -Reduced feeding cost -Reduced disease risk
AI protocol	Intra-cervical	Post-cervical	-higher conception rate
Sire selection	Based on phenotype	Best linear unbiased prediction (BLUP)	-allows for selection of multiple traits
Feed formulation	Based on crude protein	Based on essential amino acid requirements	-reduced feed cost per unit weight gain -reduced environmental impacts due to reduced excretion
	Whole grain and mashes	Pelleting feed	-improved digestibility and feed efficiency -Reduces nitrogen and phosphorous excretion resulting in reduced carbon footprint
Stunning	Mechanical/electrical shock	CO <sub>2</sub> stunning	Allows group stunning reducing pre-slaughter handling stress
Education	Government extension agents	-Use of cooperatives -Research to farmer models	-Easy access to current research output

While these challenges have obvious negative effects on productivity, adoption of technology, innovations and good management practices are key in impacting on bio-economic indicators in piggeries. It is in this context that this study undertook a detailed technology audit of the piggery value chain with the aim of contributing to improved livelihoods and incomes of pig farmers and other key stakeholders while creating stronger market linkages along the key nodes of the pig value chain.

## **1.2 Rationale**

Pig farming in Rwanda has experienced progressive growth in the last 5 years with the number of pigs increasing by 76% to over 1.7 million<sup>1</sup>. Pig production is concentrated in southern and western parts of Rwanda. The Integrated Household Living Conditions Survey (2013-2014)<sup>8</sup> also showed a marked increase in the percentage of households raising pigs from 24% to 32% nationally. The majority of producers are smallholder farmers who rear pigs in their backyards and house them in semi-permanent structures<sup>9</sup>. The geographic location of the country provides good market potential for pigs; in particular, the Eastern Democratic Republic of Congo is an important export market. Of all dressed meat in Rwanda, 21% comes from pigs<sup>10</sup>. However, local production, though increasing, is still not able to satisfy the local demand since it grows at a slower rate than the demand

## **1.3 Objectives of the Study**

The overall objective of the assignment was to establish the current available technology and technological capability in the piggery value chain (PVC) in Rwanda.

### **1.3.1 Specific objectives**

This assignment assessed potential for:

- i. Upgrading (moving to a higher value-added component of a piggery VC).
- ii. Extending (actions to broaden an existing piggery VC to increase its full potential job creation and value-added impact)
- iii. Optimising (actions to improve operation of certain links of the piggery VC to achieve greater value added).

### **1.3.2 Scope**

The consultancy activities were conducted countrywide. The Consultants assessed the technology and technological capabilities of over 80% of the existing piggery farming, marketing, processing and consumption. These involved desk studies, formal and informal stakeholder consultation, triangulations and statistical data analyses, validation of findings and recommendations, an ex-ante bio-economic feasibility plan, and development of framework for competitive grants investment in up-scaling, out-scaling and updating technologies, service delivery (advisory and financial) and private sector participation.

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<sup>8</sup> EICV<sub>4</sub>, 2013-2014

<sup>9</sup> Mbuza *et al.*, 2016

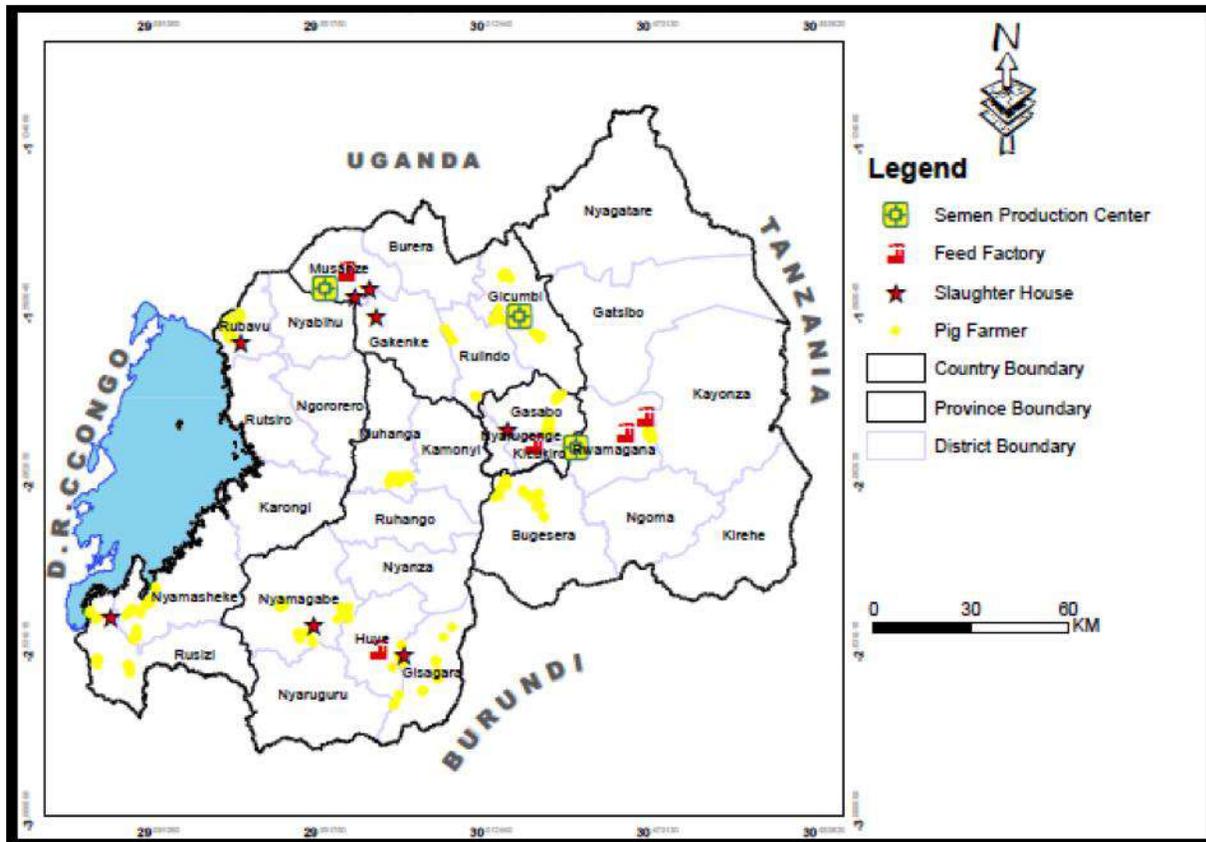
<sup>10</sup> Rwanda Livestock Master plan 2017

## 1.4 Study design and methodology

This section provides a detailed description of the study's design and methods of sampling, data collection and management protocols.

### 1.4.1 Study area

This study was carried out across the country with the sample distributed across 11 districts as shown in the Figure 1.



**Figure 1 GIS projection map of Rwanda showing the study area and sampling sites**

### 1.4.2 The study design

This study was explanatory in nature and used mixed method design to meet its objectives. This approach provided in-depth information and knowledge of the problem as well as a rich dataset. The study design consisted of two phases where the quantitative phase was dominant, implying more weight given to qualitative data<sup>11</sup>. Data from focused group discussions and key informants

<sup>11</sup>Creswell, J. W., & Plano, C. V. L. (2011). Designing and conducting mixed methods research. Los Angeles: SAGE Publications.

were used to complement the quantitative results. A Literature review was critical in informing the questionnaire for quantitative data and also key areas of interest for discussion with focus group and key informants. Qualitative data was key in informing and explaining statistical findings and trends derived from quantitative data analysis.

#### **1.4.3. Sampling technique**

Purposive sampling technique was used in selecting individuals for focus group discussion using community fora. The technique was also used in identifying key informants among partners and stakeholders. Individual farmers were selected with assistance from district and sector extension officials. It was important to divide the sampling frame into homogeneous strata in order to increase the efficiency of the sampling design. Stratification was achieved by considering each province as a stratum where the district was the primary sampling unity (PSU).

#### **1.4.4 Sampling frame and sample size**

Pig farmers in Rwanda constitute 30.6%<sup>12</sup> of all farmers. The proposed sample size was designed to obtain precise estimates for the main indicators targeted by this study. The total of 332 pig farmers were sampled from 11 districts as shown in Table 2. (see list of participants in Appendix III)

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<sup>12</sup>NISR, 2017. Agricultural Households Survey Report. December, 2018. Kigali Percentage of households raising different types of livestock by province and sex of household head

**Table 2 Sample size allocation per sector**

<b>Province</b>	<b>Selected Districts</b>	<b>Selected Sectors</b>	<b>Number of farmers</b>	<b>Total farmers per district</b>
<b>Kigali</b>	Gasabo	Ndera	10	30
		Bumbogo	10	
		Rutunga	10	
	Muhanga	Ndiza	10	32
		Shyogwe	12	
		Nyamabuye	10	
<b>South</b>	Gisagara	Save	10	30
		Gishubi	10	
		Kansi	10	
	Nyamagabe	Tare	10	30
		Cyanika	10	
		Buruhukiro	10	
	Nyamasheke	Ruharambuga	10	30
		Karengera	10	
		Bushekeri	10	
<b>West</b>	Rusizi	Gihundwe	10	30
		Gitambi	10	
		Gashonga	10	
	Rubavu	Cyanzarwe	10	30
		Rugerero	10	
		Rubavu	10	
	Rulindo	Kisaro	10	30
		Bushoki	10	
		Shyorongi	10	
<b>North</b>	Gicumbi	Kageyo	10	30
		Mukarange	10	
		Nyamiyaga	10	
<b>East</b>	Rwamagana	Muhazi	15	30
		Muyumbu	15	
		Bugesera	10	
		Nyamata	10	30
		Ntarama	10	
		Mayange	10	

A total of 47 other value chain actors were interviewed and included operators in 7 slaughter houses / slaughter slabs (Huye, Rusizi, Rubavu, Gakenke, Musanze, Rulindo and Kicukiro), 5 animal feed manufacturers, at least one input supplier, one pork trader and one slaughter slab operator in each of the 12 districts as shown in Table 3 .

**Table 3 Distribution of other value chain players sampled**

<b>Province</b>	<b>Selected Districts</b>	<b>Slaughter house/slab</b>	<b>Vet drug shop</b>	<b>Pork meat trader</b>	<b>Feed factory</b>
Kigali	Kicukiro	1	1	1	1
	Gasabo	1	1	1	
South	Muhanga	1	1	1	
	Gisagara	1	1	1	
	Nyamagabe	1	1	1	
	Huye	-	-	-	1
	Huye	1	1	1	
West	Nyamasheke	1	1	1	
	Rusizi	1	1	1	
	Rubavu	1	1	1	
North	Rulindo	1	1	1	
	Gicumbi	1	1	1	
	Gakenke	1	1	1	
	Musanze	-	-	-	1
<b>East</b>	Rwamagana	1	1	1	1
	Bugesera	1	1	1	1
<b>Total</b>		<b>14</b>	<b>14</b>	<b>14</b>	<b>5</b>

#### **1.4.5 Data collection**

The study used both quantitative methods for the measurement of the variables and qualitative methods from the collective opinions of the respondents. Data were monitored and checked for completeness on a daily basis during data collection. Phase one of the study was a reconnaissance survey. The latter is essential for the purpose of establishing control points and collection of first-hand information of various field data. Since the entire study was explorative and generic in nature, a mix of quantitative and qualitative data was collected from various stakeholders.

#### **1.4.6 Desk Review**

The desk review entailed published, reported and grey literature on the currently available technology and technological capability in the PVC in Rwanda. This review focused on various documentations including National Livestock Master Plan, PSTA4, NST1, and NIRDA's open call to provide an advisory note to the Open Call Project Selection Committee for further consideration.

#### **1.4.7 Quantitative data**

The quantitative data was collected from primary and secondary data sources. Secondary data sources entailed extraction of official government documents, private sector reports and other relevant documents. This step mainly focused on generating information on the existing technology for pig production, post-harvest handling, marketing innovations and access to financial support. For primary data, the individual farmers, pig meat processors, input suppliers and consumers were interviewed using a pre-tested semi-structured questionnaire. The quantitative phase employed participatory techniques and the inclusion of socio-economic analysis. These two were critical to revealing information that facilitated improved planning for service provision and technology adoption.

An ex-ante bio-economic feasibility study of the PVC was carried out by focusing on the existing production systems to forecast their profitability and investment opportunities. Policy options for the optimization of the PVC were suggested.

#### **1.4.8 Qualitative data**

The qualitative phase included key informant interviews, focussed group discussions and participant observation as described hereafter.

##### **i. Key informant interviews**

These included subject area experts and senior technical government officers under MINAGRI, RAB, the Ministry of Trade and Industry (MINICOM), NIRDA, Rwanda-Food and Drug Authority (Rwanda FDA). Other key informants included Rwanda Federation of Pig Farmer Cooperatives, Rwanda Council of Veterinary Doctors (RCVD) and Rwanda Private Sector Federation (PSF), Business Development Fund (BDF). In total, 19 KIIs have been conducted (See Appendix I).

##### **ii. Focus Group Discussions (FGD)/Organized Farmer Community Conversations**

Farmers were consolidated in groups of 5-10 to get accurate and reliable information on the inventory of existing technologies for production, post-harvest handling practices, marketing innovations including traceability systems, access to advisory and financial services. The groups were informed on the intent and purpose of study. In total, 12 FGDs were conducted across the country were conducted with 88 participants (See Appendix II).

A total of 21 pork and pork product traders which included supermarkets, bars and butcheries and 63 consumers were also interviewed (see Appendix IV and V).

All interviews and discussions have been undertaken using photos and video-recorded in local language. The KII and FGD were transcribed word-for-word and translated into English. Further the discussions strived to understand the context of the existing technologies in the piggery VC:

- What are the constraints and opportunities in the piggery value chain?
- Are farmers aware of the economic benefits of adoption of technology in the piggery value chain?
- The need to broaden the scope of pig production research and to increase the supply of targeted advice to pig farmers.
- The need to improve the marketing opportunities available to pig farmers.

A questionnaire was developed by the consultant and was presented to the client particularly the assignment supervisory team for their review and approval, the questionnaire included questions that addressed the study purposes and upon approval the approved version was translated in Kinyarwanda the language better understood by the respondents and was uploaded to electronic devices (tablets) equipped with the latest version of survey ODK a software package that helps to collect high-quality data using android powered devices such as tablets, or using web. These ICT-based data collection methods contributed to rapid data collection and entry and ensure a higher level of objectivity in both data collection and analysis as responses were recorded directly on the tablet device, there was no need of data entry and this reduced the likelihood of errors.

Data were collected using tablets and have been automatically transmitted and entered into a database for downloading and quality checks and then merged with others, the merging of data was necessary to bring together the data collected at different time periods and in different regions into one dataset. This was useful since geographical data have been collected.

### **1.5 Data Management, Processing and Analysis**

The consulting team used a combination of data analysis methods (descriptive analysis, content analysis, quantitative/statistical analysis and comparative analysis). This mixed methods approach allowed for triangulation and findings are supported by a range of sources and types of data (subjective, objective, and quantitative).

### **1.5.1 Quantitative Analysis**

The completed questionnaires were checked and cleared through field quality control procedures by the data manager. The questionnaires were then forwarded to the central data entry office, where two office editors reviewed every questionnaire. The dataset was then imported to the R-statistical software. Data were summarized in tabulation and charts in order to generate descriptive statistics on a number of project beneficiaries. The descriptive statistics includes percentages, frequency tables, arithmetic mean, standard deviation and cross-tabulations of the sample demographics.

### **1.5.2 Qualitative Analysis**

KIIs were transcribed and protocols for coding each transcript have been categorized and organized. This was the first step in identifying themes. Codebook development was followed through an iterative process informed by the evaluation purpose, interview guide content and preliminary findings based on the quantitative aspect of the study. The consultants conducted a pilot coding exercise to establish coder consistency protocols and further organize document families, code families and individual codes. After coding was complete, the evaluator's queries on the coded data to analyse the content and themes that emerge from the qualitative study, draw out data to interpret, triangulate and validate the findings. Summative content analysis was used to analyse the data. By exploring reoccurring themes.

### **1.5.3 Ex-ante Bio-Economic Model**

An *ex-ante* Bio-Economic Model was used to evaluate the biological and economic aspects of smallholder pig production in Rwanda. In this study, a deterministic model was developed and utilized to evaluate the biological and economic aspects of smallholder pig production systems that vary in production potential. The model focused on the inputs and outputs on each phase of the pigs' life cycle from piglet through weaning, grower, replacements to breeding stage. This model included but not limited to certain reproductive variables such as farrowing interval, age at first farrowing, pre-weaning daily gain, post-weaning daily gain, mature live weight for pigs, sow survival rate, litter size, piglet survival rate, dressing percentage, farrowing rate, weaning

age, gestation period and marketing prices. The profit function was derived as the difference between revenue (R) and costs (C)<sup>13</sup>.

The revenue (R) per pig per year will be calculated as:

$$R = R_{weaner} + R_{growers} + R_{cullsows} + R_{cullboars}$$

And the cost shall be calculated as follows:

$$C = C_{Fpiglets} + C_{Fgrowers} + C_{Freplacement} + C_{Fsows} + C_{Fboar} + C_{Hpiglets} + C_{Hreplacement} \\ + C_{Hsows} + C_{Mweaners} + C_{Hgrowers} + C_{Hsows} + \textit{Fixed Costs}$$

The upper-case letters refer to **F**eeding, **H**usbandry and **M**arketing costs. The model proposed will simulate the lifetime performance of pigs in a farrow to finish operation, and the results will be customized to account for a farrow to weaned operation for purposes of comparing profitability

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<sup>13</sup> Mbuthia et al., 2015. Breeding objectives for pigs in Kenya. I: Bio-economic model development and application to smallholder production systems.

## CHAPTER TWO

### SITUATION ANALYSIS OF THE PIGGERY VALUE CHAIN IN RWANDA

#### 2.0 Introduction

Pig production is among the fastest growing livestock sub-sector. The government of Rwanda has put in place a five-year Master Plan for the development of livestock sector with much focus on white meat industry, of which pig and pig products take the lead. Pig production in Rwanda is gaining importance owing to the shift from ruminant to monogastric livestock production, as is the case in many developing countries. Pigs have a shorter life cycle with higher return rates and better feed efficiency for conversion to meat than ruminant livestock and require less space.

Among the challenges that hinder growth of the Rwandan piggery value chain are lack of suitable infrastructure (water supply, slaughterhouses, pig markets), feed quality and availability, poor pig husbandry, access to veterinary and meat inspection services.

#### 2.1 Pig production in Rwanda

Pig production is a popular enterprise among smallholder farmers and is concentrated in the southern and western parts of Rwanda as shown in Table 4. The indigenous family pig system involves keeping of 1 – 2 local breeds of sows in the backyard which are fed on crop residues and kitchen waste. Some piglets are also kept for fattening or sold to other farmers where there are insufficient resources to keep them.

**Table 4 Distribution of pig farmers by province in Rwanda**

Province	Percentage of pig farmers	Number of pig farmers
Kigali city	8.5	4,505
South	57.4	269,206
West	26.2	95,892
North	20.5	70,725
East	16.7	76,319
<b>TOTAL</b>		<b>517,140</b>

Pigs are usually confined and sometimes left to scavenge when not tethered. The semi-intensive system is also practiced where improved breeds are kept and some commercial pig production management principles applied.

Pig farming in Rwanda has experienced progressive growth in the last 5 years with the number of pigs increasing by 76% to over 1.7 million<sup>12</sup>. The Integrated Household Living Conditions Survey (EICV)-2013-2014<sup>14</sup> showed a marked increase in the percentage of households raising pigs from 24%<sup>15</sup> to 32%<sup>8</sup> nationally. The majority of producers are smallholder farmers who rear pigs in their backyards and house them in semi-permanent structure<sup>5</sup>. The number of pig keeping households is comparable to that of poultry farmers with a significantly high proportion of women participating in pig production as shown in Table 5.

**Table 5 Comparison of monogastric livestock keeping practices by province and sex of household head**

	Households raising livestock (000s)					
	Pigs	Hen	Other poultry	Rabbits	Other livestock	No of households
Rwanda	30.6	33.7	8.2	15.0	8.9	1,690
Province						
Kigali	8.5	46.3	2.3	13.2	1.2	53
South	57.4	44.0	24.0	33.2	24.9	469
West	26.2	25.5	1.9	8.7	3.9	366
North	20.5	28.5	1.0	9.3	4.7	345
East	16.7	32.0	3.1	6.0	0.7	457
Sex						
Male	31.5	36.2	7.8	15.8	8.6	1,240
Female	28.0	6.7	8.0	12.9	9.8	449

Source: NISR, AHS 2017<sup>16</sup>

### 2.2.1 Classification of pig production systems in Rwanda

Different typologies of classification of production systems have been used in other studies to help in meeting their objectives with ease. The Rwanda Livestock sector analysis (R-LSA)<sup>17</sup> which was undertaken by the International Livestock Research Institute (ILRI) used 2 typologies; (a) based on climatic conditions and (b) based on input and outputs. However, the study assumed that the performance of monogastric animals (pigs and chicken) is not zone

<sup>14</sup>Integrated Household Living Conditions Survey (EICV<sub>4</sub>), 2013-2014

<sup>15</sup>Integrated Household Living Conditions Survey (EICV<sub>3</sub>), 2010-2011

<sup>16</sup>National Institute of Statistics of Rwanda, AHS, 2017

<sup>17</sup> International Livestock Research Institute (2017). The Rwanda Livestock sector analysis

specific. Pig production systems were therefore classified as family systems and pig fattening systems. The family systems which are widely practiced in Rwanda are household managed systems with a large part of production going to household consumption and some to generation and diversification of domestic incomes. These systems are characterised by low inputs, investment in infrastructure and dependence on domestic labour. The indigenous family pig system involves keeping of 1 – 2 local breeds of sows in the backyard which are fed on crop residues and kitchen waste. Some piglets are also kept for fattening or sold to other farmers where there are insufficient resources to keep them. Pigs are usually confined and sometimes left to scavenge when not tethered.

Specialized systems are modern production systems which are characterised by high input cost, investment in infrastructure with the objective of profit maximization. These systems however are very few and contributed only 0.02% to the livestock GDP in 2016/2017<sup>17</sup>. The study therefore further used the more universal classification of production systems based on level of intensification and housing practices to include intensive systems, semi-intensive systems and extensive systems.

An increase in intensive systems with total confinement of pigs is often associated with decreased availability of land as well as increased access to information on production and health<sup>18</sup>. The semi-intensive system is also practiced where improved breeds are kept and some commercial pig production management principles applied. This system is different from the intensive system in that, pigs are allowed to stay outdoors for some time as opposed to being fully confined. The extensive pig-production system is the simplest in terms of costs of investment. This system is often practiced in rural areas by the very poor pig farmers who tend to invest in a low cost and low output farming system. This practice characterizes subsistence production in livestock sub-sectors in most Sub-Saharan countries.

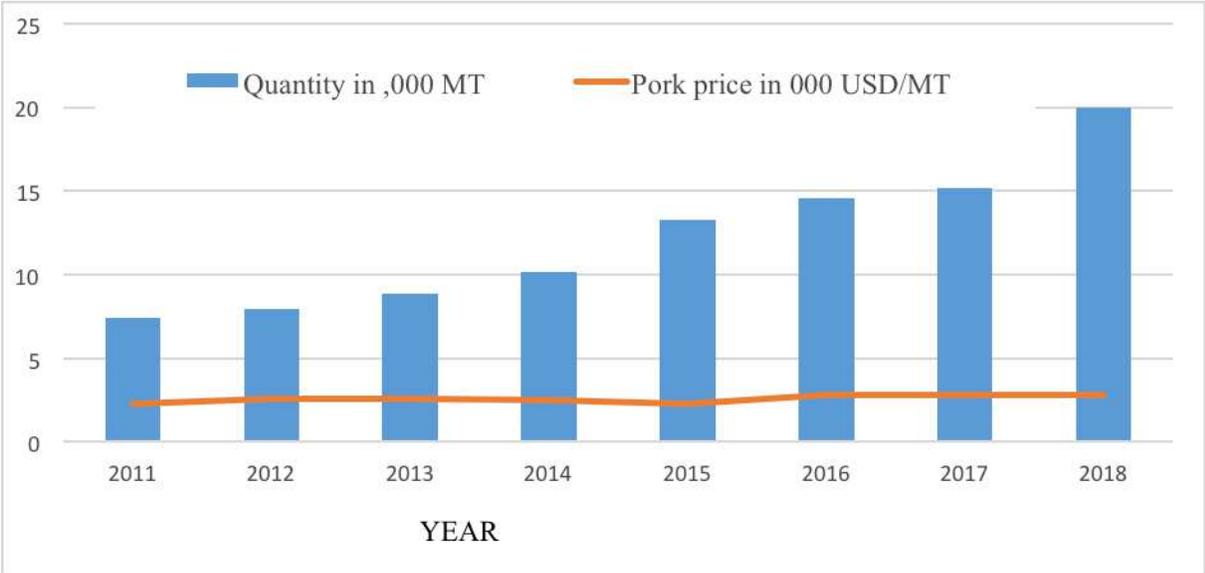
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<sup>18</sup> International Livestock Research Institute (2013). Successes and failures of institutional innovations to improve access to services, input and output markets for smallholder pig production systems and value chains in Uganda. <https://livestockfish.cgiar.org>

Due to the limited number of producers practicing specialised fattening systems, this study adopted the level of intensification to define production systems. This system is also ideal in that it makes it easier to monitor growth and investment.

**2.2.2 Pig production trend in Rwanda**

Pig production in Rwanda has shown consistent growth between 2011 and 2017 as shown on Figure 2 rising to 15210 MT in 2017. The unit price of pork however remained relatively constant over the same period. This implied that there was an unmet demand for pork since the price remained relatively constant even with increased supply.

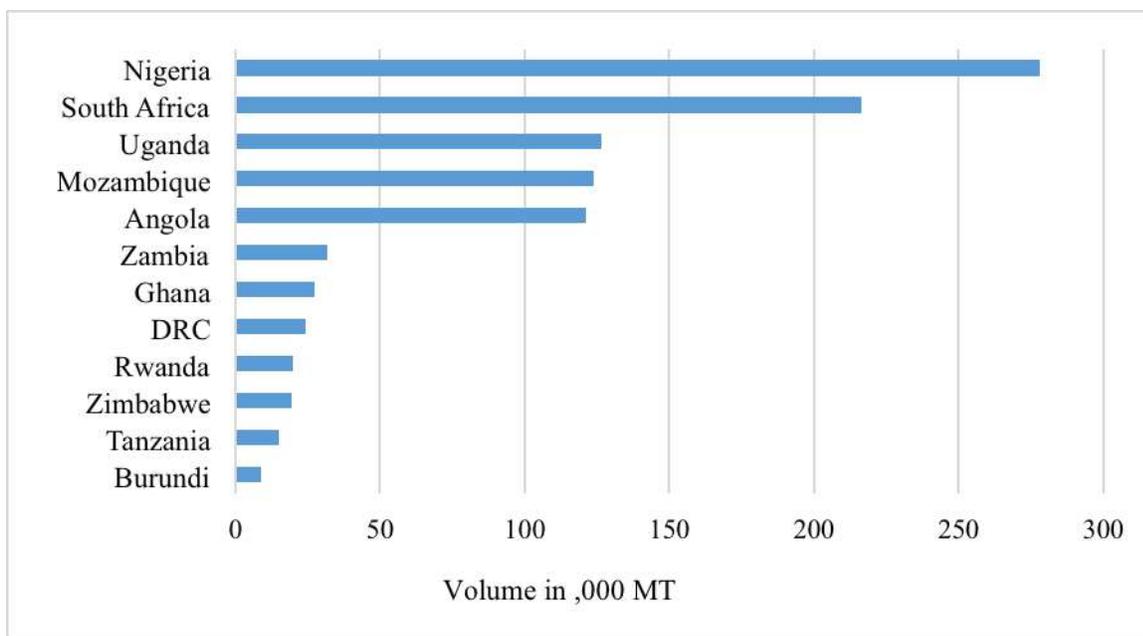


Source: FAOSTAT DATA, 2019

**Figure 2 Pig production trend and market prices in Rwanda between 2011 and 2017**

**2.2.3 Comparison of production volumes with countries in Africa**

The largest pig producers in Africa are Nigeria and South Africa as shown in Figure 3. Implementation of the 5-year Rwanda pig development roadmap will place the country among the major pig producers in the continent.



*Source: FAOSTAT DATA, 2019*

**Figure 3 Comparison of production volumes with countries in Africa**

### 2.2.4 Projected growth in pig production

The pork value chain’s development road map 2017/2018 – 2021/2022 overall target under the recommended level of investment is to raise pig meat production from 19,945 tonnes in 2016/17 to 67,076 tonnes by 2021/22<sup>10</sup> as shown in Figure 4. These targets are to be achieved through improving the family mixed pig system (IFP) and expanded commercial specialised piglet fattening (CSP). It is assumed that in these systems, the number of sows per farm will increase from 1 to 6. Other assumptions include a pre-weaning mortality rate of 10%, post-weaning mortality rate to decrease from 4% to 3%, adult mortality rates to decrease from 3% to 2%, cost of veterinary services to double and percentage of feed purchased to increase from the current 30% to 50%.

Under the commercialised piglet fattening systems, the number of fattened piglets is projected to grow to 266,251 and pork production to increase to 39,805 tonnes over the 5-year period. It is assumed that health and biosafety systems will be improved to control infectious disease outbreaks.

The contribution of pork to GDP from IFP is expected to grow to 41,877 million RWF by 2021/2022, an increase of 99% while that from CSP will grow to 24,389 million RWF. This is expected to yield a total change of 214% in pork’s contribution to GDP.



Key: IFP= family mixed pig system, CSP= commercial specialized piglet fattening

Source: LMP, 2017<sup>10</sup>

**Figure 4 Pork production projections based on indigenous family pig and commercial piglet fattening systems**

### 2.3 Piggery value chain actors

The value chain map on Figure 5 shows the different actors from production to consumption. Majority of pig farmers are smallholders in mixed farming production systems. Live pig traders often offer transport for live pigs and deliver them to slaughterhouses or live pig markets. The main outlets for pork and pork products include export of live pigs and to the DRC, hotels, restaurant and bars and supermarkets.

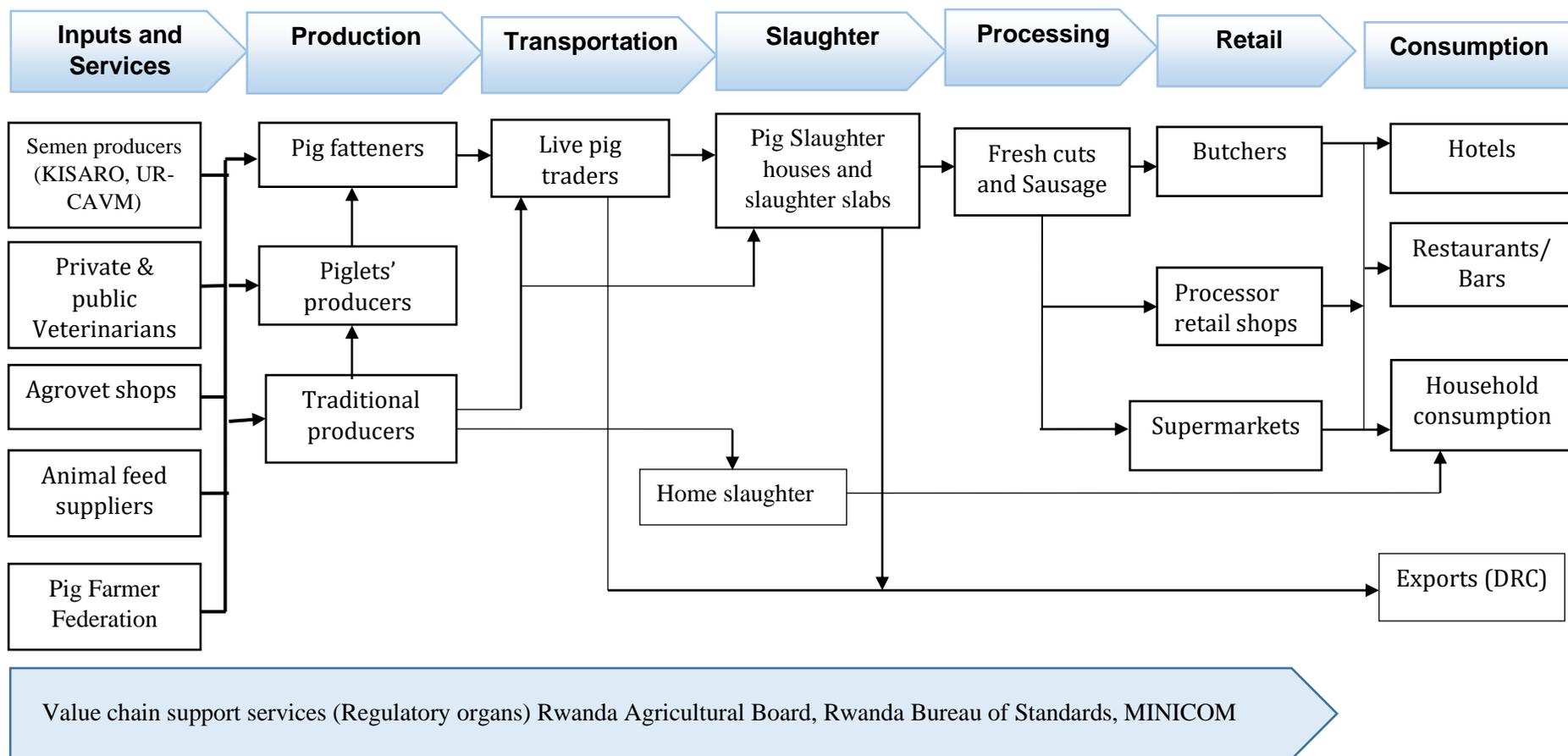
Rwanda has only 2 standard pig slaughter houses located in Rubavu and Kacukiro Districts. These slaughterhouses are inadequate to cater for the rapidly rising pig population currently at 1.7 million. Most of the pork sold in the local market is slaughtered in unhygienic conditions posing a risk of food borne infections. Such meat is often not inspected thereby posing a risk of zoonotic infections such as porcine cysticercosis to consumers.

Value chain support services include the regulatory organs mainly, Rwanda Agricultural Board through the Veterinary department and the Agricultural Exports Regulatory Board which are involved in animal health and regulation of agricultural exports. The Rwanda Standards Board is also key as the quality assurance and certification body. MINICOM plays both a regulatory as well as a facilitator role by helping to create an enabling environment for trade.

## **2.4 Pig and pig products marketing in Rwanda**

The pig production and marketing in Rwanda lack specialization. Most farmers often sell pigs irrespective of their age. Weaned pigs are the most popular category of market pigs among buyers. The most common modes of marketing pigs are farm gate sales and at very few public markets in the farmers locality. The geographic location of the country provides good market potential for pigs; in particular, the Eastern Democratic Republic of Congo is an important export market. According to the Rwanda Strategy for Export of Meat to the DRC, 25,920 head of pigs are exported monthly to the DRC. The study also reported that the demand for processed meat products in the DRC though lucrative, is insatiable and meat processors in Rwanda need to take advantage of it. Of all dressed meat in Rwanda, 21% comes from pigs. However, local production, though increasing, is still not able to satisfy the local demand since it grows at a slower rate than the demand.

Processing technologies and technical capacity in the PVC in Rwanda are inadequate. The most common practice is fresh meat cuts and traditional sausage processing, the latter being very rarely practiced. Lack of value addition to pig products precludes producers and processors from gains from value added products. Information from commercial pig centre from Rulindo district witnessed that, “If you cut pig meat according to their regions and specialities, you can sell the fresh cut up to RWF 4,000 per kilogram” —which is the double of the price for the common meat (fresh cut) on the local market.



**Figure 5 Pig value chain map in Rwanda**

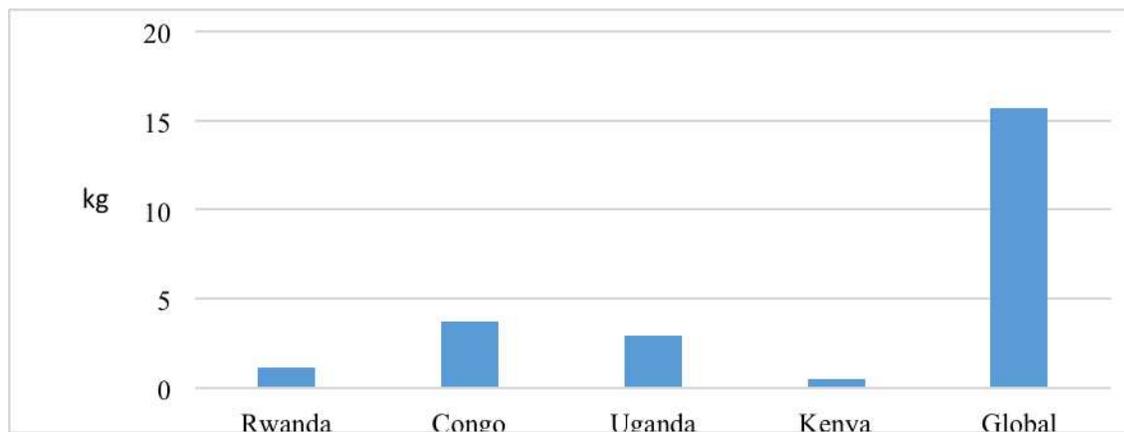
*(Source: Study conceptualisation)*

### 2.4.1 Pork exports from Rwanda

The DRC constitutes the biggest pork market accounting for over 90% of the national produce. Pork exports have also shown robust potential for growth. A pork abattoir in Rubavu District indicated that they export at least 4 tonnes of pork daily to DRC worth about 8 million RWF. Data from the National Agricultural Export Board (NAEB) shows that Rwanda pork meat exports have been steadily increasing since 2015. In the financial year 2015-2016, the annual pork meat exports were 1,253,230 Kg worth USD 4,602,638 while in 2017-2018, the total annual volumes accounted for 2,623,090 Kg with net value of USD 9,250,616 (NAEB, 2019)<sup>19</sup>.

### 2.4.2 Pork consumption in Rwanda

Data from MINAGRI shows that 21% of meat consumed in Rwanda comes from pork. The *per capita* pork consumption in Rwanda has experienced a steady growth currently at 1.11 kg. This is however far below the global average of 15.7 kg. With increasing incomes, growth of the middle-income group and rising population, the consumption of pork in Rwanda is expected to grow<sup>20</sup>. A comparison of per capita consumption with neighbouring countries shows that there is room for growth for the Rwandan piggery sector. Congo and Uganda have higher consumption *per capita* at 3.71 and 2.95 as shown in Figure 6.

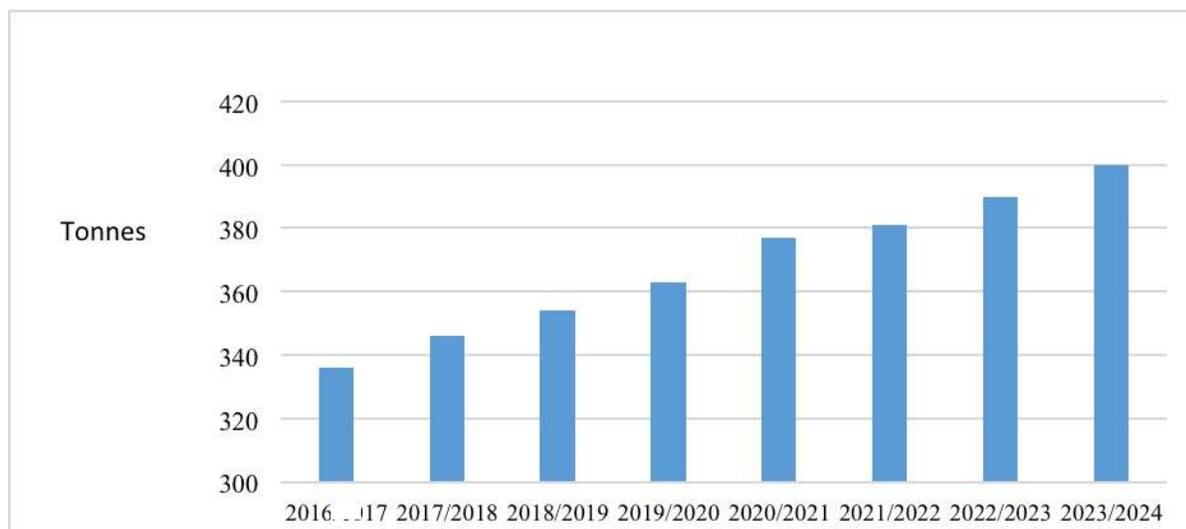


**Figure 6 Comparison of Rwanda's *per capita* pork consumption with other countries**

<sup>19</sup> Personal communication during the KII with NAEB staff in charge of exports

<sup>20</sup> <https://www.newtimes.co.rw/news/high-income-appetite-pork-drive-pig-industry>

Pork consumption is however expected to grow to 400 tonnes annually by 2024 as projected in the Rwanda economic survey (EICV5)<sup>21</sup> as shown on Figure 7.



**Figure 7 Projected growth in consumption of pork in Rwanda**

### **2.5 Current status of technology use in the piggery value chain in Rwanda**

Technology, innovations and good management practices are key to addressing the challenges that impede farm productivity. Among key technologies in pig production are breeding, animal health, information and communication, feed processing and pork value addition.

Popular pig breeds in Rwanda are exotic (Large White, Landrace, Pie train) indigenous and some crossbreeds between these exotic and indigenous ones. Recently, a new exotic breed, Duroc Jersey, was introduced in the country. There are no breeding programmes either at national or farm level. Pig producers use any type of breed depending on its availability but also production purpose. Commercial farmers often use improved breeds, while traditional farmers rely solely on the indigenous or crossbred pigs for breeding. Lack of knowledge and choice of production system are key determinants of the choice of pig breeds among smallholder farmers. A and Inbreeding is very common since farmer frequently buy male and female weaner piglet from the

<sup>21</sup> NISR, 2014. Integrated Household Living Conditions Survey 5. <https://www.statistics.gov.rw/publication/eicv-5-rwanda-poverty-profile-report-201617>

same litter as starter stock. Lack of breeding centres aggravates the inbreeding problem, and therefore, there is an urgent need to address this issue.

Artificial insemination in pigs, is not a common breeding method in Rwanda. Few semen production centres exist in the country, mainly in the Northern Province (Rulindo district-Kisaro centre and Musanze district-Busogo centre, at the University of Rwanda) and in the eastern province (Rwamagana district-Muyumbu breeding centre). At these centres, exotic breeds and their crosses are also sold to farmers. In the locations where semen is produced, the insemination cost is often a challenge for pig producers, since the cost of service is around RWF 15,000 per insemination which includes cost of semen and transport fees for the inseminator. Few veterinary technicians have been trained as pig inseminators making the service less accessible.,

Use of Information Technology (IT) in the piggery value chain in Rwanda, is almost solely limited to normal phone uses (calls and SMS) by smallholder farmers when inquiring information on the feed and pig market. It is important to note that some commercial farmers use automation in feeding and watering pigs; this is the case at CPPA Kisaro, Rulindo district, where animals get water when they push a button with their snout. This has reduced the cost associated with labour.

There are five animal feed factories in Rwanda: Kigali (Gorilla feeds), Eastern province (Afrisol and Prodey Tunga), Northern Province (Zamura feeds) and Southern province (Huye feeds). Their physical locations are very strategic to increase proximity to pig farmers. Challenges associated with raw material supply (quality and quantity), feeds demand and processing capacities hinder the profitability of these factories. Farmers' often complain that the costs of feeds as well as transport costs incurred are high.

The common pork processing is fresh cuts, without or with less processing technology. Few processors make different types of sausages, especially in Kigali. Since pork industry is emerging, there is need for capacity building and technology support to all key players of the piggery value chain. Construction of modern slaughter houses with all the requirements, including cold chain, should be given priority to maximize on pig products value addition.

## 2.6 Youth and gender participation in piggery value chain

Rwanda boasts of the most youthful population in the region with 50% (5.4 million persons) being under 20 years of age and an overall mean age of 22.7 years<sup>22</sup>. The rural population is also skewed with a higher population of females. A large proportion (83.5%) of Rwanda's population is rural despite the fact that most of the land is hilly and not arable<sup>23</sup>. Pig production is predominated by males with less than 20% of functions performed by women<sup>4</sup>. This could probably be an indicator that there are high returns in pig keeping even in the prevailing production circumstances. Various studies have shown that higher income agricultural activities tend to be predominated by men though women provide the bulk of the labour requirements.

Among the major constraints that negatively impact productivity for youth and women in agriculture is insufficient knowledge, information and education<sup>24</sup>. The second most common challenge is access to land which is vital for starting a farming enterprise. However, the GoR has been keen in addressing these shortcomings through policy interventions concerning the land tenure system. The Rwanda Law No. 43/2013<sup>25</sup> provides for equal access to land without discrimination based on sex or origin.

Inadequate access to financial services is the third principle challenge<sup>17</sup> which is associated with lack of collateral and lack of financial literacy. Limited access to markets associated with the low scale of production and stringent market standard requirements could also pose a challenge to youth and women investment in pig enterprises.

According to PSTA<sup>426</sup>, women have a higher propensity to work in agriculture than men (92 per cent compared to 77 per cent<sup>27</sup>). Women empowerment is crucial for both women's own and national socio-economic development and is therefore a core component in most intervention areas. It is linked to many positive spill-over effects on the overall economy including household

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<sup>22</sup>2012. Rwanda Fourth Population and Housing Census.

<sup>23</sup>NISR, 2016. Rwanda Demographic and Health Survey 2014-15 (2014-15 RDHS)

<sup>24</sup>Youth and Agriculture; Key Challenges and Concrete Solutions. FAO, 2014. [https://images.agri-profocus.nl/upload/Article\\_FAO\\_CTA\\_IFAD1468313004.pdf](https://images.agri-profocus.nl/upload/Article_FAO_CTA_IFAD1468313004.pdf)

<sup>25</sup>Law No. 43/2013 of 16/06/2013 Governing Land in Rwanda. [http://gmo.gov.rw/fileadmin/user\\_upload/laws%20and%20policies/Law N\\_43-2013\\_of\\_16-06-2013\\_governing\\_land\\_in\\_Rwanda.pdf](http://gmo.gov.rw/fileadmin/user_upload/laws%20and%20policies/Law_N_43-2013_of_16-06-2013_governing_land_in_Rwanda.pdf)

<sup>26</sup>Rwanda Strategic Plan for Transformation of agriculture 2018-2024. Ministry of Agriculture and Animal Resources.

<sup>27</sup>NISR, Population Census 2012

members' health, food security and nutritional status, and reduction of gender-based violence and discrimination. Empowerment of women in PSTA 4 focuses on training and capacity development in leadership and management skills for women to actively participate in decision-making at the household, cooperative, community, and institutional level.

### **2.7 A SWOT analysis of the piggery value chain**

An analysis of the strengths and weaknesses of the piggery value chain as shown on Table 6 was critical in this study in identifying key areas where investing in technology would increase incomes of participants.

**Table 6 A SWOT analysis of the pig value chain in Rwanda**

<b>Strengths</b>	<ul style="list-style-type: none"> <li>• Existence of a strong enabling environment</li> <li>• Wide base of farmers practicing pig keeping</li> <li>• Existence of a pig farmers’ interest group (Rwanda Pig Farmers Association) to champion the interest of pig farmers</li> <li>• Short production cycles for pigs with faster returns on investment</li> </ul>
<b>Weaknesses</b>	<ul style="list-style-type: none"> <li>• Inadequate and poor-quality feeds</li> <li>• Unavailability of or high cost of breeding stock and artificial insemination services</li> <li>• Low productivity of existing pig breeds and infertility related to inbreeding</li> <li>• Inadequate extension services</li> <li>• Low rate of technology adoption at all levels of the value chain and poor husbandry</li> <li>• Lack of sufficient or accessible quality slaughter facilities</li> <li>• Weak access to credit facilities</li> </ul>
<b>Opportunities</b>	<ul style="list-style-type: none"> <li>• Increasing local demand for pork</li> <li>• A large unmet demand of pork and pork products in DRC</li> <li>• Relative increase in the price of other meats in comparison to pork</li> <li>• Increasing preference for pig keeping due increasing pressure on land due to increasing population</li> <li>• Opportunity to increase profits through making own feeds hence reducing production cost</li> <li>• High potential of increasing employment in pig production, feed processing, marketing and processing</li> </ul>
<b>Threats</b>	<ul style="list-style-type: none"> <li>• Competing interest from neighbouring countries</li> <li>• Weak compliance to quality standards</li> <li>• Infectious Diseases such as African Swine Fever (ASF), Foot and mouth disease (FMD) and swine erysipelas</li> <li>• Zoonosis such as cysticercosis</li> </ul>

## CHAPTER THREE

### RESULTS

#### 3.0 Introduction

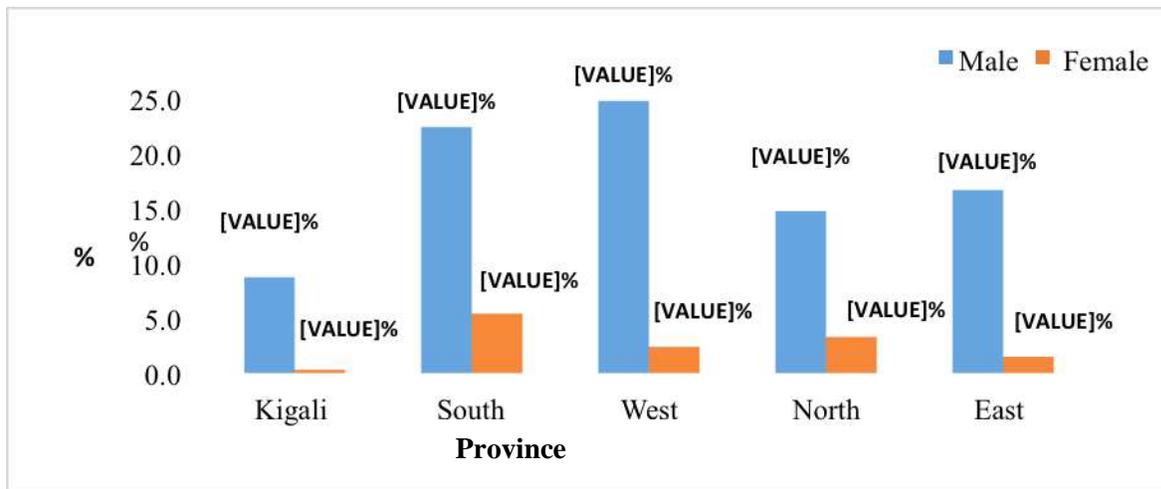
In this chapter, key findings from the interviews with pig farmers, key informants and Focused Group Discussions are presented. Findings on the general characteristics of the sampled households, pig production systems, technology, gender and youth

#### 3.1 Socioeconomic characteristic of pig enterprises in Rwanda

This section presented results on the socio-economic characteristics; gender, age and literacy level of pig farming household heads.

##### 3.1.1 Gender of household head

More men were involved in the pig farming activities than women 71.6% of households interviewed were male headed and 28.4% were female. This pattern was observed in all provinces as shown in Figure 8. Women were involved mainly in activities such as feeding, marketing of pig and pig products and meat processing (minced meat, sausage).



**Figure 8 Participation in pig farming by gender in provinces in Rwanda**

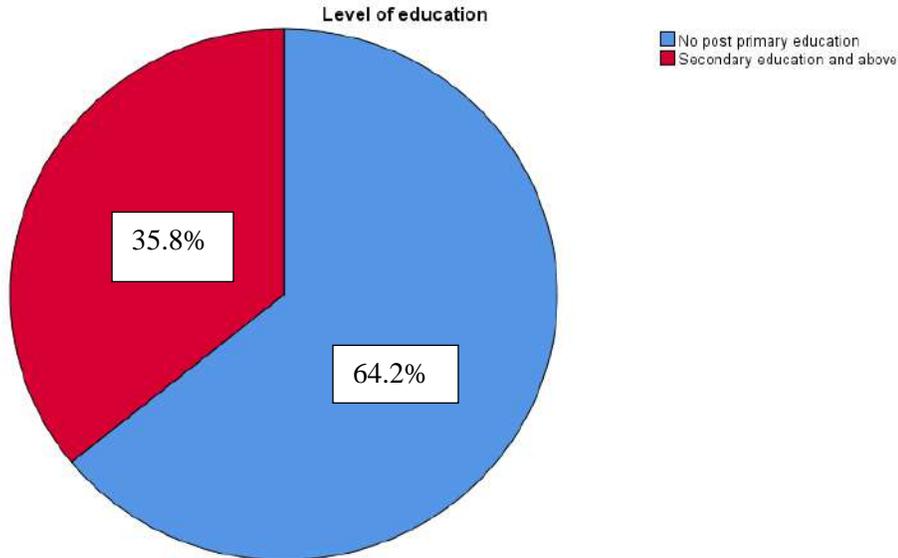
##### 3.1.2 Age of household head

Participation of youth (18 – 30 years) in pig production was low with 9.6% of household heads with pig enterprises. Pig farming was predominantly (82.2%) practiced in households where the head was between the age of 31 and 60 years. There were 8.1% of pig farmers who were older

than 60 years. Age of the household head is an important determinant of access to factors of production which influences the level of investment and by extension production efficiency.

### 3.1.3 Level of education

Majority (64.25) of pig farming household head had no post-primary education (Figure 9). This was an important finding because literacy level is considered an important determinant of decisions relating to adoption of agricultural technologies.



**Figure 9 Literacy level of household heads**

### 3.1.4 Pig farming experience

Pig farmers had a mean pig farming experience of  $1.4 \pm 0.5$  years. Though pig farmers producing under extensive systems had a numerically higher mean, the difference with those under intensive and semi-intensive was not significant. This finding has two implications; either the turnover of participants in pig production is high or alternatively there is a lot of interest in pig farming and therefore, the high number of new entrants. The second argument is plausible owing to demand pull from the pork market.

## 3.2 Pig production in Rwanda

This section describes pig production practices in Rwanda as well as associated challenges.

### 3.2.1 Pig production systems

Majority (65.6%) of smallholder pig farmers practice intensive husbandry system (Table 7). This trend was similar ( $p \leq 0.05$ ) in all provinces apart from Southern Province where the extensive husbandry system was practiced by 54% of smallholders.

**Table 7 Pig husbandry systems practiced (%)**

Production systems	Province					Total (N=332)
	Kigali (N=30)	South (N=92)	West (N=90)	North (N=60)	East (N=60)	
Intensive	93.3	35.6	60.7	79.7	89.7	65.6
Extensive	3.3	54	9	11.9	5.2	20.4
Semi-intensive	3.3	10.4	30.3	8.4	5.1	14

$$\chi^2_{(8)} = 114.3, p \leq 0.05$$

Majority (63.8%) of smallholders practice the farrow to finish pattern of production. Pig production patterns differ significantly between provinces ( $p \leq 0.05$ ). The farrow to finish system is the most popular in Kigali, South, West and East. Majority of smallholders in the North prefer to purchase growers for finishing while those in Kigali entirely produce their own piglets as shown in Table 8.

**Table 8 Pig production patterns practiced (%)**

Pig systems	Province					Total (N=332)
	Kigali (N=30)	South (N=92)	West (N=90)	North (N=60)	East (N=60)	
Farrow to finish	96.7	52.9	73	23.7	89.7	63.8
Grower to finish	3.3	23	14.6	54.2	3.4	21.1
Farrow to wean	0	24.1	12.4	22.1	6.9	15.1

$$\chi^2_{(8)} = 88.7, p \leq 0.05$$

### 3.2.2 Pig housing

Pig housing structures are significantly different ( $p \leq 0.05$ ) between husbandry systems. Majority of small holder pig farmers (66.4%) kept their pigs in permanent housing. In the intensive and semi intensive husbandry system, permanent housing was predominant while the proportions of temporary and permanent housing in the extensive system were comparable ( $p \leq 0.05$ ). More than half of pig houses in intensive systems had concrete floors while over 70% in extensive systems had earthen floors. Iron sheets were the most favorite roofing material and were used by 80% of

small holder pig farmers. Majority of pig houses in intensive and semi intensive had iron sheet roofs while 50% in extensive systems had other types of roofing material such as thatch (Table 9).

**Table 9 Comparison of housing structures between production systems**

Pig housing	Pig husbandry system				Significance $\chi^2$
	Intensive	Semi- intensive	Extensive	Overall	
Pig housing					
Permanent	86.3	68.9	47	66.4	43.9(2)**
Temporary	13.7	31.1	53	33.6	
Floor type					
Concrete	52.8	44.4	7.6	42.4	104.9(4)**
Earthen	11.3	35.6	74.2	27.6	
Others	35.9	20	18.2	30	
Roof material					
Iron sheets	92.5	77.8	40.9	79.9	85.3(4)**
Others	5.2	17.8	50	16.1	
No roof	2.3	4.4	9.1	4	

*Key: Numbers in parenthesis indicate degrees of freedom, \*\* = significant at  $p \leq 0.05$ .*

### 3.2.3 Pig inventory

Smallholder pig enterprises in Kigali city had the highest ( $p \leq 0.05$ ) mean herd size with 12.2 pigs while South and East Provinces had the lowest values; 7.2 and 7.3 respectively (Table 10).

**Table 10 Comparison of the mean number of pigs per enterprise between provinces**

	Province					ANOVA (F)
	Kigali N=30	South N=92	West N=90	North N=60	East N=60	
No of pigs	12.2 (9.3)	7.2 (5.3)	9.6 (8.2)	8 (7.9)	7.3 (7.7)	3.3**

*Key: Numbers in parenthesis are standard deviations, \*\* =  $p \leq 0.05$*

The mean number of pigs per enterprise was significantly higher ( $p \leq 0.05$ ) in intensive systems compared to semi-intensive and extensive husbandry systems with 9.8, 7.2 and 5.7 respectively (Table 11). The mean number of boars and sows per herd was significantly higher ( $p \leq 0.05$ ) in intensive compared to extensive systems. In all systems, the boar: sow ratio is greater than 0.5 indicating a high population for boars in pig enterprises.

**Table 11 Comparison of the mean number of pigs per enterprise between husbandry systems**

Mean	Husbandry system			ANOVA
	Intensive	Semi-intensive	Extensive	
No. of pigs	9.8 (8.7)	7.2 (4.0)	5.7 (4.7)	8.6**
Boars	3.8 (4)	2.5 (2)	2.2 (2.7)	6.4**
Sows	6 (6.1)	4.7 (3)	3.5 (2.8)	6.3**
Growers	3.9 (5.7)	2.8 (2.6)	3.6 (5.2)	0.9

*Key: Numbers in parenthesis are standard deviations, \*\* =  $p \leq 0.05$*

The mean value of pigs in enterprises under intensive systems was significantly higher ( $p \leq 0.05$ ) compared to either extensive or semi-intensive systems as shown in Table 12. The mean values of boars, sows and post-weaning piglets in intensive system were higher than in the extensive and semi-intensive systems while the mean values of barrows and gilts were comparable.

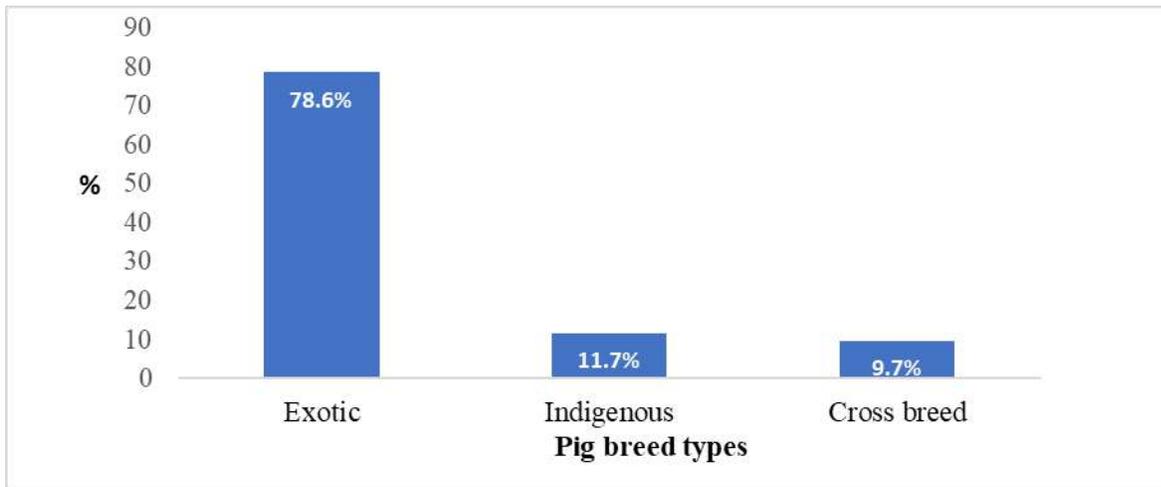
**Table 12 Comparison of the mean value of pigs in Rwandan Francs in smallholder enterprises**

Pig group	Husbandry system			ANOVA (F)
	Intensive	Extensive	Semi-intensive	
Boars	184,885 (133,958)	99,469 (107,188)	104,244 (88,649)	11.6**
Sows	484,854 (356,197)	216,590 (159,769)	297,688 (215,432)	22.0**
Growers	313,498 (455,542)	285,852 (419,102)	223,958 (209,038)	0.9
Post-weaning	96,099 (112,983)	29,859 (44,132)	78,085 (102,517)	11.5**
Overall	1,079,338 (795,020)	631,771 (559,894)	692,245 (380,700)	13.1**

*Key: Numbers in parenthesis are standard deviations, \*\* =  $p \leq 0.05$ , 1RWF = 0.001 USD*

### 3.2.4 Pig Breeds kept by farmers in Rwanda

Regardless of the sex (boars or sows), exotic breeds<sup>28</sup> (78.6%) are predominantly represented across the country, while indigenous breeds represent 11.7% and crossbreed<sup>29</sup> are found to represent 9.7% (Figure 10). Predominant exotic breeds found in Rwanda are Large White, Landrace and Pie train and Duroc Jersey. Majority of pig enterprises (88.7%) had a breeding boar on the farm. Breeding boars in Rwanda were predominantly exotic breeds 73.9% with a much lower proportion of crossbred (10.9%) and indigenous (15.2%) breeds.

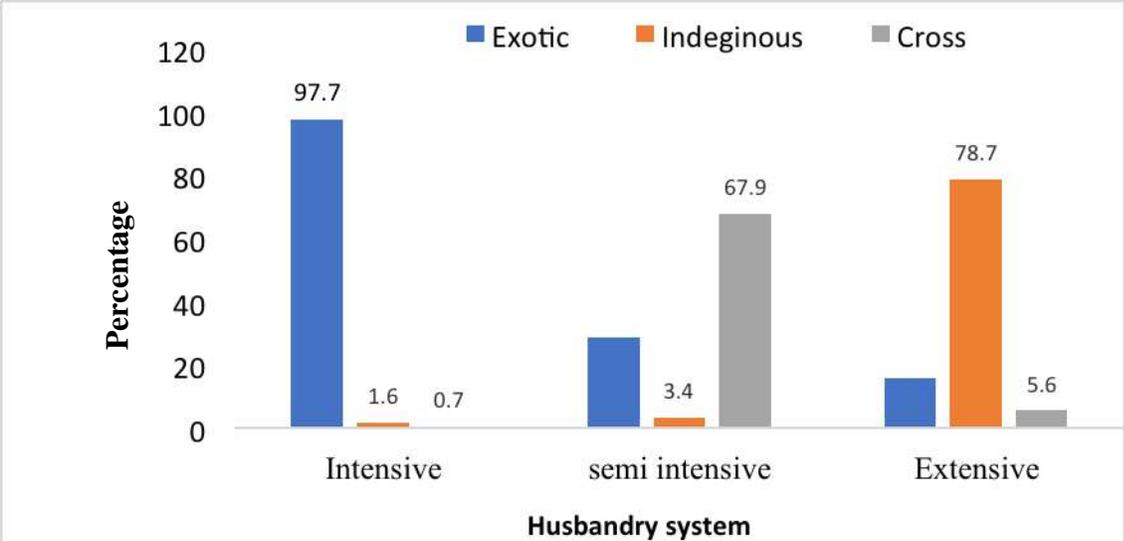


**Figure 10 Distribution of pig breeds in smallholder pig farmers in Rwanda**

The breeds of boars kept for breeding varied between production systems with exotic breeds predominating in intensive systems and indigenous breeds predominating in extensive systems (Figure 11). Smallholder farmers in semi-intensive systems used both exotic and crossbred boars with minimal use of indigenous breeds.

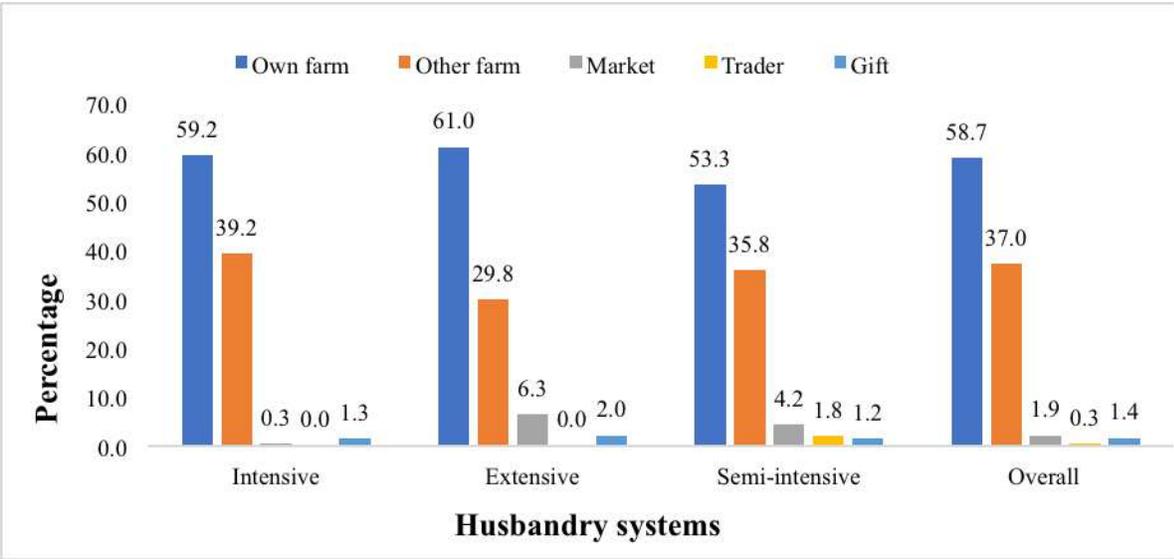
<sup>28</sup> The term “Exotic breeds” is used in the results to refer to pigs that phenotypically present with predominant features or a combination of features of common imported breeds such as Landrace, Yorkshire, Pietrain and Duroc Jersey. They are frequently crosses of these breeds rather than pure lines.

<sup>29</sup> “Crossbreed” was used in this study to mean the of-springs or progenies of crosses between indigenous and exotic breeds of pigs.



**Figure 11 Percentage composition of breeding boars in smallholder pig enterprises**

Over 70% of breeding sows in pig enterprises in Rwanda consisted of exotic breeds (Figure 12). Some of the sampled enterprises (6.1%) had no breeding sows. In intensive systems, breeding sows consisted almost entirely (97%) of exotic breeds while in extensive systems, 85% of breeding sows consisted of indigenous breeds. In semi-intensive systems, 72% of sows were crosses between exotic and indigenous breeds.



**Figure 12 Percentage composition of breeding sows in smallholder pig enterprises**

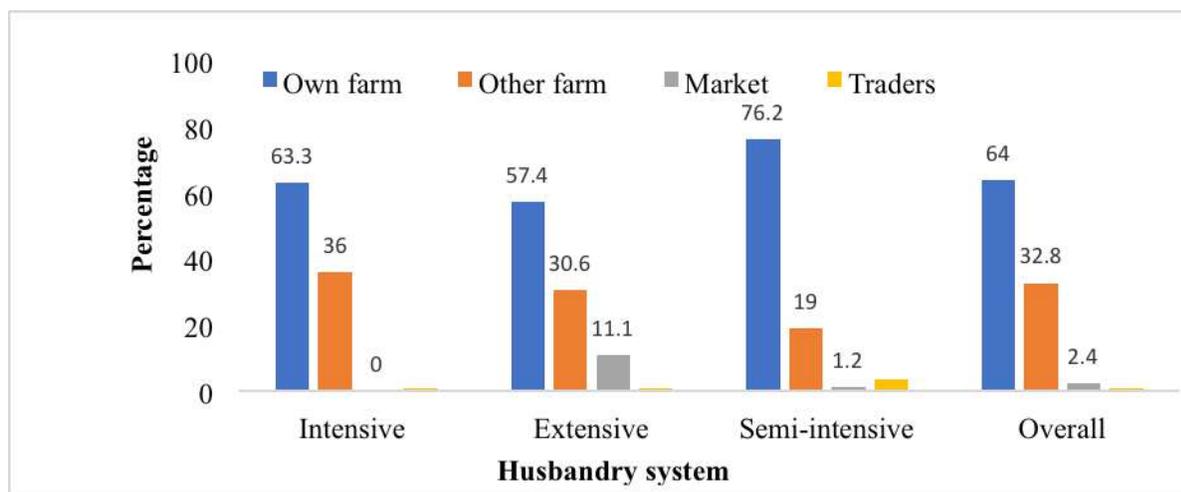
### 3.2.5 Pig breeding practices in Rwanda

Natural mating was widely used by pig farmers in Rwanda. Artificial insemination services were only used in 34.5% of inseminations recorded in the Northern Province while none was recorded in the other provinces as shown in Table 13.

**Table 13 Sow Insemination choices of pig farmers**

Breeding method used	Province					Total
	Kigali	South	West	North	East	
Natural mating	65	58	127	97	67	414
Artificial Insemination (AI)	0	0	0	51	0	51
Total	65	58	127	148	67	465

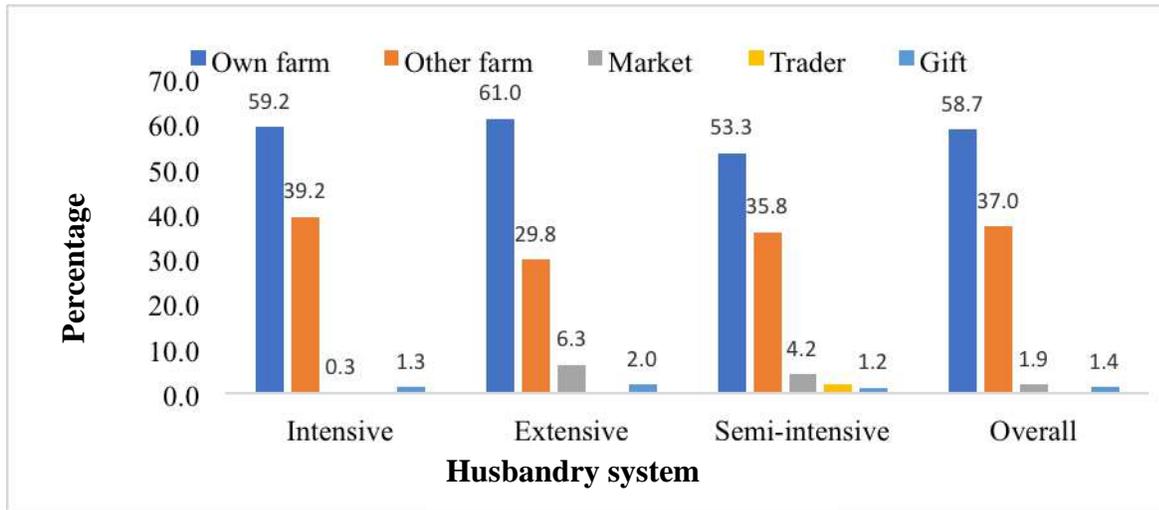
Majority (64%) of smallholder pig farmers in Rwanda obtained breeding boars from their own herd. Markets and traders were rarely used in sourcing breeding boars, however, about a third of farmers obtained breeding boars from other farms. This pattern was observed in all production systems as shown in Figure 13. This finding had implications for inbreeding and the associated problems of infertility and inbreeding depreciation.



**Figure 13 Sources of breeding boars**

Majority (59%) of pig farmers in Rwanda obtained breeding sows from their own herd. Markets and traders were rarely used as sources of breeding sows, however, 37% of farmers obtained breeding sows from other farms. This pattern was observed in all production systems as shown in Figure 14. It is very important to note that inbreeding phenomenon is occurring in pig farming in

Rwanda, therefore, there is need to promote the use of artificial insemination to overcome this genetic problem.



**Figure 14 Sources of breeding sows**

### 3.2.6 Pig feed resources in Rwanda

Majority (75.7%) of smallholder farmers fed their pigs on commercially compounded feeds which included 88%, 75% and 53% in intensive, semi-intensive and extensive systems respectively. Pig diets were varied with multiple types of alternative feed resources. These included agro-industrial by-products (85.3%), green fodder (83.1%), home-made feeds (63.8%), institutional swill (62.6%) and post-harvest farm residue (60.7%). Market fruit and vegetable waste and slaughterhouse waste were used at a lower rate; 14.7% and 9.5% respectively.

#### *Non-conventional feed resources*

There were different types of non-conventional feedstuffs which were locally available. These included;

- Animal offal
- Blood meal
- Traditional brewery waste (*Ibivuzo*)
- Molasses
- Stinging nettle (*Igisura*)
- Chayote (*Ibidodoki*)
- Maggots and termites

### 3.2.7 Routine management practices

The most commonly carried out management practices among smallholder pig farmers were worm control, spraying of acaricides to control external parasites and administration of iron injection to piglets. Pig weighing, castration of male piglets and teeth clipping in piglets were practiced at a lower frequency (Table 14).

**Table 14 Rank analysis of routine management practices carried out by smallholder pig farmers**

Management practice	Husbandry system			Overall
	Intensive	Extensive	Semi- intensive	
Iron injection	<b>2.50</b>	<b>1.48</b>	<b>2.20</b>	<b>2.25</b>
Castration	1.62	1.42	1.42	1.55
Teeth clipping	1.67	1.11	1.31	1.50
Spraying	<b>2.43</b>	<b>1.79</b>	<b>2.18</b>	<b>2.27</b>
Deworming	<b>2.69</b>	<b>2.32</b>	<b>2.60</b>	<b>2.60</b>
Weighing	1.75	1.45	1.31	1.63

*Key: Numbers in bold indicate the 3 highest scores*

### 3.2.8 Pig marketing practices

Pig farmers sold their pig mainly through 4 channels that included the following: i) Individual buyers (81%) who included other farmers and traders/brokers and consumers ii) Processors (10.2%) who included slaughter slab owners, iii) Wholesalers and large consumers (13.3%) such as supermarkets and iv) Retailers who included butcheries (22%), bars (5.1%) and restaurants (3.6%). A total of 14 pig markets were identified by pig farmers as their points of sale. Majority (65%) of pig farmers obtained information on pig markets from other farmers. Majority (68%) of pig farmers reported that they determined the price of their pigs which was different from the situation with pig farmers in neighbouring Uganda and Kenya who are to large extent price takers.

Majority of smallholders in intensive systems sold their breeder pigs to butchers (53.7% and 76.8% of sold sows and boars respectively) and growers (Barrows and gilts) and post-weaning piglets to other farmers (52.2% and 93.6% respectively). In extensive systems, most sows, boars, growers and post-weaning pigs were sold to other farmers.

### **3.2.9 Record keeping in smallholder pig enterprises**

More than half (58%) of smallholder pig farmers often kept piggery records, that is, 68% in intensive, 46.7% in semi-intensive and 36% in extensive systems. Among the commonly kept records were health (46.4%), feeding (40.4%), sow breeding and farrowing (49.2%), pig mortalities (24%), production and financial records (36.3%).

### **3.3 Ex-ante bio-economic model: Evaluating performance using bio-economic indicators**

The bio-economic model was derived from inputs and outputs values which were used in computing revenues and costs used in evaluating the biological and economic aspects of smallholder pig production systems. The model was used to evaluate the gross margins of pig enterprises in Rwanda using the profit function and the results were presented in Table 15.

Though the results indicated a favourable gross margin of approximately 34%, the gross profit was relatively low. However, investment in technology could provide a solution to low revenues by increasing production efficiency.

The factors that contribute to low revenues in smallholder pig production systems were the low volumes of pig sales attributed to low fertility. As observed in the model, the litter sizes were low (7.2 piglets) and the situation was worsened by a high pre-weaning mortality (9.72%). The revenue from sale of weaned piglets is also much lower than that of sale of mature pigs for slaughter. This is indicative of a high demand for weaned piglets, an enterprise that can be up-graded and up-scaled.

The cost of feeding contributed 50% to the total enterprise costs. In an ideal situation where only pre-formulated commercial feeds are used in pig feeding, this cost is likely to go up to about 70 – 80% depending on the scale of production. In the case of Rwanda, most pig farmers used alternative feed resources including agro-industrial by-products, home-made feeds, green fodder and farm residue. These however may not accurately meet the pigs' nutritional requirements and may result in poor performance as was in in the bio-economic indicators (age at first farrowing, farrowing interval, litter size, pre-weaning mortality). There is however need to evaluate the various local feedstuffs for nutritional value so as to develop a protocol that can be used in training pig farmers on pig feeding.

**Table 15 Bio-economic model: Computation of 12-month gross margin using enterprise revenue and cost of production**

<b>Yield</b>	<b>Metrics</b>	<b>Amount</b>
No of boars	2.04	
No of sows per unit (A)	3.94	
Farrowing interval (B)	201 Days	
Number of litters per year (C)	$365/(B) = 1.82$ litters	
Litter size (D)	7.2 piglets	
Pre-weaning mortality (E)	9.72%	
Piglets weaned per year	$= A*C*D*(1-E) = 46.6$	
Percentage sold at weaning	60.2%	
Number of weaned piglets sold	$60.2%*46.6 = 28.1$	
Number of growers sold	1.81	
Number of boars sold	1.5	
Number of sows sold	1.29	
Mean price of weaned piglets		RWF 29,859
Mean price of growers		RWF 80,625
Mean price of boars		RWF128,154
Mean price of sows		RWF 118,523
<b>Total revenue from pigs sold</b>		<b>RWF 1,430,093</b>
<b>Total cost of production</b>		
Daily cost of feeding boars		RWF 453.06
Daily cost of feeding sows		RWF 529.18
Daily cost of feeding growers		RWF 219.56
Daily cost of feeding post weaning piglets		RWF 250.93
Annual cost of feeds (365 days)		RWF 530,248.00
Annual cost of labour		RWF 141,609.90
Marketing costs		RWF 54,204
Transport cost		RWF 289,328
Veterinary costs		RWF 37,085.90
Total costs		<b>RWF 1,052,475.8</b>
<b>Gross profit per sow year</b>		<b>RWF 24,325.13</b>
<b>Gross margin</b>		<b>35.9%</b>

*All costs were computed based on values provided in the survey (1 RWF = 0.0011 USD)*

### 3.4 Common challenges in pig production in Rwanda

This section discusses the various challenges identified that pose a threat to increasing productivity in piggery enterprises in Rwanda.

#### 3.4.1 Pig diseases and disease syndromes

Results on pig losses showed that pig enterprises in Rwanda encountered significant losses arising from disease related mortalities as shown in Table 16.

**Table 16 Losses associated with pig mortality due to disease in Rwandan pig enterprises**

Age group	Percentage of piggeries that reported losses in 12 months	Mean value of loss per piggery (RWF)
Boars	7.9%	34,667 (8,880)
Sows	14%	80,090 (15,803)
Growers	10.8%	40,714 (18,880)
Post-weaning piglets	10.6%	30,000 (2732)
Pre-weaning piglets	30%	30,000 (3710)

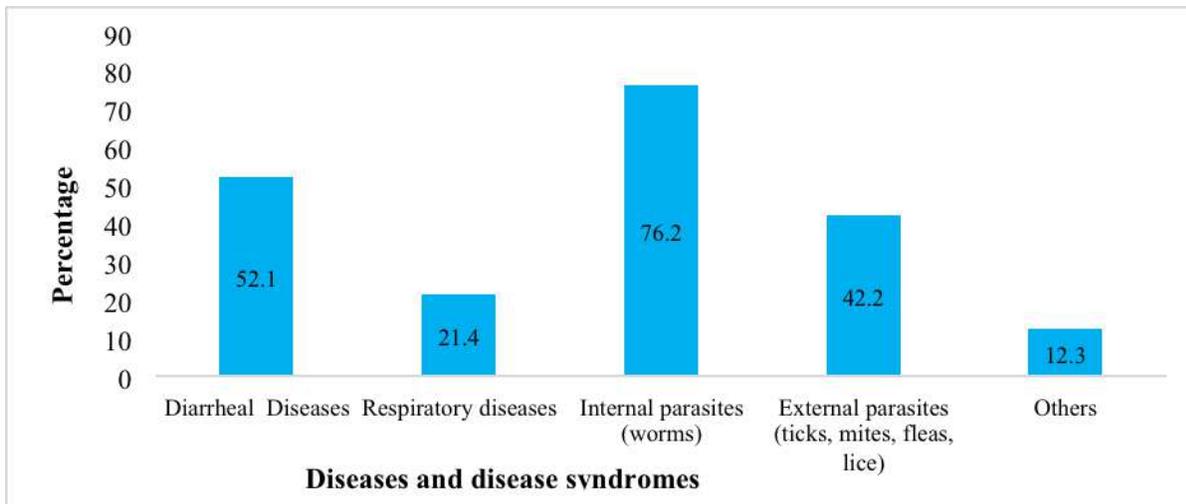
*Key: Numbers in parenthesis are standard errors of the means*

The high mortality rate in pre-weaning piglets is a key indicator of poor management of parturient sows and piglets most likely associated with poor housing and nutrition. The high incidence of mortalities due to disease for sows (14%) in comparison to growers and boars was due to the fact that their herd life is often longer by virtue of being the unit of production. Among the common causes of death in piggeries reported in literature and by key informants were;

- i. In pre-weaning piglets:
  - Crushing by dams
  - Hypothermia associated with poor housing
  - Hypoglycaemia due to lack of suckling where sow is sick or a poor mother
  - Piglet anaemia
  - Pneumonia
  - Diarrhoeal diseases particularly caused by *E. coli* and *Clostridia species*
  - Swine erysipelas
  - African swine fever
- ii. In post-weaning piglets, growing pigs and adult pigs

- Pneumonia
- African swine fever
- Swine erysipelas
- Injuries associated tethering (septic wounds inflicted by tethering rope) and during transport
- Heat stroke in tethered pigs
- Poisoning (salt)

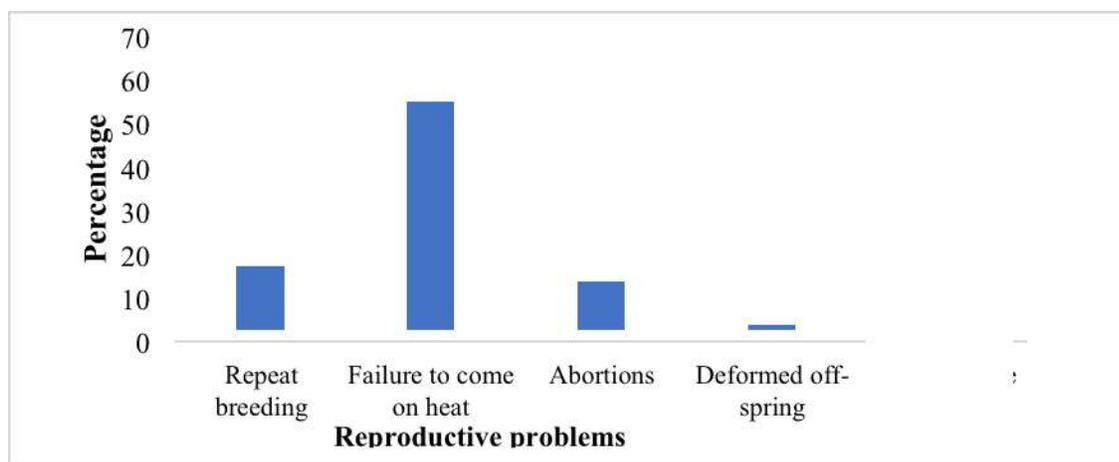
High incidence of endoparasites (76.2%) was the most common disease reported by farmers followed by diarrheal diseases (52.1%) as shown in Figure 15. Though farmers were not able to precisely tell which diseases affected their pigs, they mentioned a number of clinical signs such as fever, lack of appetite, coughing, and ataxia which are common with infectious diseases. Cysticercosis and Ascariasis were the common findings at the slaughter houses/slabs that were visited therefore corroborating the initial finding of a high incidence of endoparasites. High incidence of internal parasites particularly cysticercosis is often a common finding in extensive system and is a public health concern due to its zoonotic characteristic.



**Figure 15 Common diseases of pig in Rwanda**

Reproductive problems were identified as a serious challenge faced by pig farmers. Failure to come on heat (57.2%), repeat breeding (19.3%) and abortions (16%) were found to be the most common issues impeding reproductive performance among smallholder pig farmers as shown in Figure 16. These could be attributed to use of low-quality feeds as well low technical capacity

resulting in failure to identify sows on heat. The occurrence of deformed off-springs in 6% of pig enterprises is a significant finding since it could be an indicator or inbreeding in pig herds.



**Figure 16 Common reproductive problems among smallholder farmers**

### 3.4.2 Access to quality pig feeds

The most common challenges associated with use of commercial pre-formulated feeds among smallholder pig farmers were high cost of feeds, weak purchasing power and high transport cost. Other challenges included lack of stockists/dealers, lack of knowledge on which feeds to use and poor feed quality of available feeds as shown in Table 17. Key informant interviews with R-PFA also cited the high cost and low quality of feed as challenges for pig producers.

**Table 17 Rank analysis of challenges associated with use of commercial pre-formulated feeds**

Challenges associated with use of pre-formulated feeds	Husbandry system			Overall
	Intensive	Extensive	Semi-intensive	
High cost of feeds	<b>3.76</b>	<b>3.80</b>	<b>3.96</b>	<b>3.79</b>
High transport cost	<b>2.85</b>	2.23	<b>3.36</b>	<b>2.79</b>
Lack of stockists/ dealers	2.80	2.02	3.11	2.68
Poor feed quality	2.41	<b>2.89</b>	3.13	2.61
Weak purchasing power	<b>3.61</b>	<b>3.06</b>	<b>3.71</b>	<b>3.51</b>
Lack of knowledge	2.44	2.82	3.20	2.62

*Key: Numbers in bold indicate the 3 highest scores*

### 3.4.3 Access to good breed of pigs

The average age at first service for pigs in Rwanda was 12.2 months showing that they had delayed maturity. The mean number of piglets born alive was 7.2 with a post weaning mortality of 9.6%. The mean length of the farrowing interval was 201 days implying that the mean number of weaned piglets per sow per year is approximately 11 which was significantly low compared to industry standard of 22 piglets. Key informant interview with RAB also reported that there was a high incidence of inbreeding which results in undesirable effects of inbreeding heterosis.

### 3.4.4 Access to extension services

The most common source of pig farming information is friend or other farmers (92.2%) while 37% of pig farmers access this information from the mass media (radio, television and newspapers). Government extension personnel are a very important source of extension services and are used by 71% of farmers while 8% use private extension services. A notable finding is that 40% of pig farmers used the internet to seek production information. When farmers were asked which source of information they preferred, 72% still preferred friends. These results are important in informing policy decisions on extension services since the internet has brought about a paradigm shift in service provision. There could be a number of reasons why farmers have a lower preference for government services. Such could include low accessibility as well as easy availability of alternative services such as knowledgeable farmers and the internet.

### 3.4.5 Access to veterinary services for pig farmers in Rwanda

Majority of pig farmers (77.1%) obtained veterinary services from private veterinary practitioners (Table 18). Some farmers (14.2%) reported that they treated their own pigs. The mean annual expenditure on veterinary services was RWF 38,162.

**Table 18 Sources of veterinary services for pig farmers in Rwanda**

Source of veterinary service	Whom do you obtain veterinary services from?			
	Yes		No	
	Frequency	Percent	Frequency	Percent
Private Veterinarian	256	77.1	76	22.9
Sector Animal Resources Officer	144	43.4	188	56.6
Community Animal Health Workers (CAWHs)	8	2.4	324	97.6
Self-treatment	47	14.2	285	85.8
Never treat sick pigs	3	0.9	329	99.1

### **3.4.6 Challenges associated with pig marketing**

More than half of pig farmers (52.8%) reported that the price of pigs offered in the market was a barrier in expanding their enterprises. Most participants in focussed group discussions reported that the price of pigs in live animal markets was low since the buyer was the price maker. A quarter (25.8%) of farmers reported that high licence fees was a barrier in their enterprises. Long distance to the market was a challenge to 35.6% of farmers. This was probably related to the 40.3% who reported poor infrastructure as a trade barrier.

### **3.5 Findings on pig transport slaughter and processing**

This section describes results on live pig transport, slaughter and processing.

#### **3.5.1 Pig transport**

In Rwanda, pig transportation has been associated with significant pre-harvest losses due to injuries such as fractures, cuts, skin abrasion and death due to suffocation. The transport conditions have also been associated with decrease of meat quality due to excessive pre-slaughter stress. The situation is aggravated by poor road infrastructure often resulting in long hours on the road.

##### **i. Characteristics of participants**

Majority (86%) of pig transporters interviewed were pig traders (intermediaries) who also bought pigs at farm gate. The rest of the transporters were slaughter slab operators (11%), farmers who doubled up as traders (1.6%) and hired transporters (1.4%). Majority (92%) of the transporters delivered live pigs to live pig markets for resale.

##### **ii. Technology used in transport of live pigs**

Majority of transporters (58.6%) walked pigs to the market while 22.4% used hired vehicles that were not necessarily animal transport vehicles. Pigs were also fastened on bicycles and motorcycles in 15.3% of the cases. Only a few farmers (4%) farmers used their own trucks to transport pigs. Most of the pig transport methods were inappropriate and exposed pigs to severe stress. Observation by researchers indicated that some of transporters often transported pigs even

in high temperatures during the daytime. There was also no withdrawal of feeds prior to transport thereby predisposing pigs to suffer vomiting during transport. A relatively high (16.3%) incidence of injuries to pigs during transport was reported.

### iii. Licensing of transport for pigs

Pig movement permits were sought in only 11% of cases. Statutory requirements for licensing of animal/ pig transport stipulate that they must obtain a licence from MINAGRI (DVS) and the copy of the license must be kept in the vehicle. Transporters are required to ensure the well-being of the animals throughout the transport process. A licenced transporter must not accept a pig if the animal is properly marked. Pigs from fattening units that are intended for direct release to the abattoir should be marked (marking stamp) in order to identify the issuing farm and their destination and accompanied with a delivery note. Animal transporters are also obliged to have a certificate of declaration of livestock transport trade in their vehicle indicating the licence number of vehicles, description of animals including date of transport.

#### iii. Gender participation in pig transport

Results from the study showed that pig transport was predominantly a male activity. There were no female participants in pig transport activities.

### **3.5.2 Pig slaughter**

The daily number of pigs slaughtered in slaughter slabs varied from 1 – 10 while in licensed slaughterhouses it varied from 24 – 30. These differences were due to the processing capacities, infrastructure and available market. According to RAB, there are only two (2) pig slaughterhouses that are licensed in Rwanda (Rugali Meat Processing Ltd and World meat in Bugesera)<sup>30</sup>. In some districts, there were other pork slaughterhouses which were not yet licensed due to failure to comply with various requirements such as; environmental considerations, quality issues and basic infrastructure such as water availability. At Rugali Meat Processing Ltd, animals are held in a separate hall for 24 hours before they are slaughtered. Pigs stunning, hair removal, evisceration and carcasses cutting are automatically done. Rugali Meat Processing Ltd has well-designed processing and packaging units for different pork products such as pork meat, bacon, pork fillet, pork chops, pork spare ribs, sausages and salami. The factory also has a permanent veterinarian who oversees the whole process but also meat inspection and other

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<sup>30</sup> Personal communication during the KII with RAB staff in charge of animal products inspection

quality checks. It was observed that in all the slaughterhouses visited, women are not involved in slaughter process, however, few were in processing and packaging. This was only found at Rugali Meat Processing Ltd.

None of the slaughter slabs had holding facilities before pigs were slaughtered. It was found that pigs are brought by farmers at slaughter places on the same day. The slaughter process was manually done, with negative impact on animal welfare. Stunning was done by applying a blow using a heavy object on the head. More than 80% of pig slabs did not have slaughter tables and evisceration was done on the floor and offal placed on the floor. In some cases, pig carcasses were placed on the floor exposing the meat to contamination (Figure 17). This practice was found in almost all of the slabs and backyard slaughtering.

In a number of instances, live pigs arrived at the slaughter slabs with injuries sustained during transport. In 40% of visited slaughter slabs, meat inspection was done by the sector animal resource officer where the slaughter slab was located. This was shown by an inspection stamp on the carcass for traceability and quality purpose. At Rugerero slaughterhouse and other slaughter slabs, hair removal was manually done by pouring hot water on the pig carcass and scrubbing the hair using knives.



**Figure 17 Slaughtering and evisceration room in one of the pig slabs**

*(Source: Photo by researcher)*

Poor waste management was also a common practice across all the slaughter slabs (Figure 18). Licensed slaughterhouses had an established system for waste management. The main export market for the country's pork is the neighboring Democratic Republic of Congo while the rest goes to the international market. The impacts of Covid-19 pandemic which started in November 2019 were evident in the pig trade in Rwanda where pork meat traders reported a drop in sales, both at local and international/regional markets. Rugali Meat Processing Ltd reported that they shut down their processing activities because of a sharp decline in demand for their products from the main export market, the DRC. The level of value addition to pork meat was generally very low which limits the exports. The current business model limits meat processors to increase their sale volumes because they do not slaughter their own pigs but rely on intermediaries to supply pigs from live pig markets. Limited knowledge of what the market demands, lack of equipment, infrastructure and human resource capacity to add value to the meat products are also key challenges for the pork meat trade.



**Figure 18 Pig slaughterhouse workers cleaning the place after service**  
*(Source: Photo by researcher with authority of establishment)*

**Table 19 Estimated capacities and technology needs of processing facilities visited**

Slaughtering facility	Name of slaughtering facilities	Current status	Estimated slaughtering capacity	Technology Requirements for upgrading
1) Large size (licensed) slaughterhouses	<ul style="list-style-type: none"> <li>• Rugali Meat Processing Plant</li> <li>• World Meat</li> </ul>	<ul style="list-style-type: none"> <li>• They have all the required processing capacity: 24 hour holding hall before slaughter, stunning, bleeding and hair removal facilities, hinging lines.</li> <li>• Some quality control facilities: meat inspection is done by a permanent veterinarian</li> <li>• They also have appropriate processing infrastructure: cutting table, cutting equipment,</li> <li>• Cooling facilities: cold rooms, deep freezers, chillers,</li> <li>• Presence of waste disposal facilities</li> <li>• 30 – 50 pigs are slaughtered per day</li> </ul>	More than 200 pigs can be slaughtered per day	<p>These slaughterhouses need to be upgraded by providing technical assistance, capacity building, machinery provision, adequate equipment for quality checks and traceability.</p> <p>Use of bio digesters would be an innovative approach in managing waste.</p>
2) Medium and small size slaughterhouses	<ul style="list-style-type: none"> <li>• Muryabazira Pig slaughter slab</li> <li>• Rwanza Pig slaughter slab</li> </ul>	<ul style="list-style-type: none"> <li>• Some basic infrastructure: hinging lines, meat inspection is done by a</li> </ul>	100 – 200 pigs can be slaughtered per	Construction of modern slaughterhouses with all the required facilities: Stunning equipment (electric), Hoist

ses	<ul style="list-style-type: none"> <li>• Nkotsi pig slaughter slab (Individually owned slab)</li> <li>• Rugerero pig slaughter house</li> <li>• CPPA Kisaro</li> <li>• Kamonyi pig slaughter house</li> <li>• Save slaughter slab (Gisagara)</li> <li>• Muhanga slaughter slab</li> <li>• COOCEPB slaughterhouse (Rusizi)</li> <li>• Nyamagabe (Individually owned slab)</li> </ul>	<p>district/sector veterinary officer</p> <ul style="list-style-type: none"> <li>• Lack of cooling facilities</li> <li>• Lack of waste disposal</li> <li>• 1 – 10 pigs are slaughtered per day</li> </ul>	<p>day, if all the missing facilities are provided.</p>	<p>(manual or electric), Scalding vat and dehairing machine, Scrapping/ gambrelling table (stainless steel), Electric splitting saw and breastbone saw.</p> <p>Use of bio digesters would be an innovative approach in managing waste.</p> <ul style="list-style-type: none"> <li>• Some of these slabs need to be relocated since they are located within residential houses or in the marshlands.</li> </ul>
3) On-farm slaughter slabs	<ul style="list-style-type: none"> <li>• These are slaughter slabs owned by individual farmers, they do not have specific names</li> </ul>	<ul style="list-style-type: none"> <li>• The majority of animals are slaughtered on the ground in the farm backyard.</li> <li>• No meat inspection is done</li> <li>• No storage facilities</li> <li>• No waste disposal facilities</li> </ul>	<p>There is a need to construct mini slabs at sector level so that individual farmers can bring their animals there. If all the requirements are met, at least 10 animals can be slaughtered per day.</p>	<ul style="list-style-type: none"> <li>• Farmers should be encouraged to bring their animals to the nearest slaughter houses/slabs to stop these backyard slaughters.</li> </ul>

### **3.6 Marketing of pork and pork products**

This section presents the study findings on pork meat retailers who included supermarkets, bars and restaurants. The study was however conducted during the lockdown due to the Covid-19 pandemic. As such, most pork outlets were closed and limited information was available concerning their operations. All bar owners where pork was sold reported that Covid-19 had a huge impact on their business since their bars were shut down.

The main source of pork sold in bars was individual farmers who slaughtered pigs at their farms. The pork was often not inspected and had no inspection stamps on them. The pork was delivered to the bars in unhygienic containers/ carriers such as sacks predisposing it to spoilage. Many of these outlets had no running water or cold storage facilities. Losses due to spoilage were common with most reporting monthly losses of between 5-10kg of pork. Bar owners reported that before the lockdown, they would sell between 400 – 1,000kg of pork per month. The pork meat prices varied from 3,000 – 6,000 RWF/kg of fried pork.

In the supermarkets, pork meat is sold at 4,200 RWF/kg while sausages are sold at 5,100RWF/kg. The main challenges cited by pork meat traders include;

- Lack of meat transportation facilities (refrigerated vehicles),
- Lack of slaughterhouses in close proximity which makes the transport cost high,
- Lack of processing equipment (electrical cutting machine, proper weighing equipment),
- Lack of storage facilities (refrigerators, freezers)

### **3.7 Consumer perceptions**

#### **i. Consumers' preference of pork in comparison to other meats**

Pork contributes 21% of the *per capita* meat consumption in Rwanda and is therefore a meat of choice. The most common points of access of pork for consumers include bars (53.2%), home slaughter (22.6%) with the rest coming from butcheries. This indicates that there is a need to increase formalisation pork retail trade. Majority of consumers (53.3%) preferred pork to other meats because it tasted better while 40% felt it was healthier. Price of pork had minimal influence on preference to other meats. Negative attitude towards pork was mainly associated with religious and cultural beliefs.

#### **ii. Product preference**

Most consumers preferred pork with skin removed (24.1%) and with less fat (34.5%). Those consumers who bought pork from pork eateries preferred both roasted (46%) and fried (54%) pork. The most popular processed pork product was pork sausage which was regularly consumed by 54.8% of respondents. Other products included bacon (9.7%), salami (22.6%) and lard locally known as *Amavuta y'ingurube*<sup>31</sup> (12.9%).

iii. Perception on quality

Pork slaughtered in the backyard did not go through the formal meat inspection procedures but was eventually delivered to pork outlets. As a result, 16.9% of respondents felt that pork offered for sale was low in quality. This indicated that improving pork quality could have a significantly positive effect on volumes of pork sold.

### 3.8 Summary findings of focussed group discussions

Since the study was conducted when the country was under lockdown due to the Covid-19 pandemic, preventive measures were applied to avoid the spread of the disease among participants; social distancing, face masks, washing hands and or use of hydrogels. Each FGD consisted of 5 – 10 farmers. A number of guiding questions helped to get views and opinions on the piggery value chain in Rwanda, focusing on the challenges faced by pig farmers.

It was found that many farmers decided to do pig production as a source of income for immediate household needs such as paying school fees for their children, source of manure as they were all involved in subsistence crop farming. Some challenges that have significantly affected their business in terms of income generation were reported and farmers proposed some recommendations to overcome these challenges.

Low investment in piggery, lack technology to upscale their business, land scarcity, lack of infrastructure (slaughter houses, pig markets), lack of knowledge in pig farming practices and enterprise, use of indigenous breeds, high cost of artificial insemination (where this technology is available (Gicumbi, Rulindo and Rwamagana district) have been recorded as major challenges in the pig production at farm level. High cost of feeds, lack of enough water for their animals, high transport cost for feeds, inaccessibility to loans, disease incidences were also reported to hinder pig production among smallholder pig farmers.

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<sup>31</sup> “*Amavuta y'ingurube*” refers to processed fat from pigs or lard in the local language - Kinyarwanda

Lack of records in many districts was also an issue since it was not easy for farmers to estimate costs associated with any farming activities. Some farmers reported that they do not know the importance of keeping records and even those who kept them did not know the use of the recorded information. A common challenge was raised from the discussions; low price of live pigs on the market. It was revealed that farmers do not have a final decision on the prices of their animals since the buyer is the one deciding on the price.

Enabling environments were suggested by the majority of participants: having at least a slaughterhouse and pig market in each district, trainings on pig production, reduction of cost of feeds, financial support, and market linkages. Most pig farmers prefer selling piglets (young pigs) at the weaning stage since they do not have enough land to keep them to finishers. Farmers claimed that artificial insemination (AI) was very expensive (RWF 15,000/pig), therefore, they opted for natural mating over AI. Therefore, they requested to have semen production at RAB so that they can access the service in a similar way as for the dairy farmers. Alternatively, having private enterprises working in the semen production sector would also help farmers to improve the genetics of their poorly performing pigs.

### **3.9 Summary findings of key informant interviews**

The research team undertook interviews with key informants from individuals with sector specific knowledge drawn from the public and private sector in Rwanda. The purpose was to obtain their views on the different aspects of the piggery value chain (PVC). The results of these interviews were summarized and organized by PVC segment and an overview of common issues and key differences across all segments were provided.

#### **2. Rwanda Agriculture and Animal Resources Development Board (RAB)**

The Rwanda Agriculture and Animal Resources Development Board (RAB) is an autonomous body established by Law N°14/2017 of 14/04/2017. The law specifies that: RAB has the general mission of championing the agriculture sector development into a knowledge based, technology driven and market-oriented industry, using modern methods in crop, animal, fisheries, forestry and soil and water management in food, fibre and fuel wood production and processing.

It was revealed that there was no previous study on the performance and delivery of veterinary service in the PVC in Rwanda. Since 2017, the government of Rwanda has set National Livestock Master Plan on different meat commodities, including pork meat. This shows that the

PVC is gaining more importance over the last two years, therefore, the current findings will suggest a way forward in terms of veterinary service delivery in the PVC. This also emphasises why there was no current data on the service provisions. However, results from quantitative data and FGDs showed that private veterinary practitioners were the main source of veterinary service to pig farmers.

Laws and regulations are formulated at MINAGRI level, since the latter is the regulatory institution. The general regulations<sup>32</sup> on livestock and meat transport in Rwanda also apply to live pig and pig products' transport. There are no specific guidelines for pig and pig products.

Through the discussion held between the consultants and RAB's representative in this assignment, that there is no specific support to pig farmers. As an institution in charge of animal resources, RAB oversees and support any livestock activities related to its mandate, regardless of livestock species. It was important to note that during the Covid-19 pandemic period, livestock farmers got special support to access financing through subsidies. The RAB intends to import boars to support pig semen production centres so that the cost of Artificial Insemination in pigs should reduce. These boars will be given as subsidies in the genetic improvement program. The project is intended to kick-off in July 2020.

Public veterinary officers at sector level—known as Sector Animal Resources Officers (SAROs) have heavy workload which doesn't allow them to offer veterinary services to all farmers. It can be seen that privatization of veterinary services would benefit a lot to farmers since they will get a proximity service from private veterinarians.

There is no vaccination program for pigs, but a national epidemio-surveillance strategy exists since February, 2020. This is very important for the piggery value chain, since it is an emerging sub-sector in Rwanda. It was also noted that the main prevailing disease according to RAB's reports are Swine erysipelas (*Rouget du porc* in French), a bacterial disease caused by *Erysipelothrix rhusiopathiae*, Cysticercosis and other gastro-intestinal diseases.

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<sup>32</sup> MINAGRI, 2010. Ministerial Order N°013/11.30 Of 18/11/2010 On Transport And Trade Of Meat.  
<http://www.minagri.gov.rw/index.php?id=678>

According to RAB, it is very important to re-organise the piggery value chain, especially at the level of producers, transporters, processors and pork traders. For example, some slaughter houses in Kigali will be rehabilitated to accommodate pig slaughtering since these are currently used for other livestock species (beef and goats). The market needs to be organized in such way that producers and processors are easily linked to avoid losses in form of spoilage and reduced. Slaughter houses/slabs claimed that animal identification is lacking with many pig farmers. When pigs are slaughtered and found to be sick, it often is very difficult to trace the carcass back to the producer.

Although there is no available databank, but RAB attested that there are exotic breeds (Large White, Landrace, Pietrain and Duroc), their crosses and indigenous (local) breeds. This information corroborated the results of quantitative data analysis on pig breeds. Considering the genetic improvement program, RAB is planning to upgrade and support the existing semen production centres in different ways; either by providing boars in a form of subsidy or by technical training of inseminators.

Feeds and meat prices need to be revised to make sure that all key players in the PVC benefit from their businesses. For example, the government plans to subsidize feed factories. Further, RAB will conduct research to evaluate the efficacy of local ingredients (raw materials) in feed formulation and use. This will definitely reduce the feeds production costs and in turn, improve access to pig producers. The government, through RAB, will also setup research centres across the country to support the PVC.

### **3. Enabel**

Enabel is the Belgian development agency which is currently implementing and coordinating the Belgian international development policy. Jointly with the World Bank, the United Kingdom and Holland, Belgium supports the Rwandan Ministry of Agriculture to implement Rwanda's Strategic Plan for the Transformation of Agriculture. This aims to reform agriculture from a subsistence sector into a knowledge-based value-creating sector contributing to the national economy and ensuring food and nutrition security.

Enabel is committed to provide any technical and or financial support to PVC players at any stage. This will be implemented in collaboration with RAB through NIRDA's Open Calls,

provided that the current study identifies gaps in the PVC in Rwanda. Specifically, Enabel's support will evolve around:

- Capacity building to pig producers, veterinary technicians—mainly through Artificial Insemination trainings. Pig farmers will be trained in collaboration with RAB through Livestock Farmer Field Schools (L-FFS),
- Machinery provision to slaughter houses, feed factories and other processors. It is expected that the recommendations from this consultancy exercise will inform on skills and technology gaps, from which key interventions will be drawn.

#### **4. Ministry of Trade and Industry (MINICOM)**

The mission of the Ministry of Trade and Industry (MINICOM) is to facilitate Rwanda's economic transformation through enabling a competitive private sector integrated into regional and global markets, while ensuring a level playing field and the protection of consumers.

MINICOM will support pig farmers, through RAB and RSB, to build their capacity in terms of pig production. This will mainly focus on shaping their knowledge in business-oriented farming, quality products and market linkages. Value addition is another key element that MINICOM is looking at in the PVC with aim of satisfying the local and international markets of pork meat. MINICOM is willing to support pig farmers and processors to overcome the negative impact of Covid-19 pandemic by providing them with export permits for their produce.

#### **5. Rwanda Pig Farmer Association (R-PFA)**

Rwanda Pig Farmer Association was born in 2017. Its organisational structure consists of a National Committee composed of 10 staff, of which three (3) make up a Board and seven (7) are advisors. Its main activities are to support pig farmers in terms of advocacy and capacity building through trainings. The next step in their activities is to organize farmers into cooperatives, link them to financial service providers and other input suppliers. The main challenge in this exercise is that there is no database of pig farmers in the country, since no mapping has been done so far.

Although the sector is still reorganizing itself, some challenges identified according to R-PFA:

- i. Lack of pure breeds: It was reported that the genetic makeup of the current breeding stock including exotic breeds is unknown. Inbreeding is alarming since no breeding strategic plan exists at national level (RAB).

- ii. Animal feeds: High cost of feeds, inaccessibility, and lack of knowledge of farmers in feeding practices are key challenges.
- iii. Market: The discussion with R-FPA chairperson pointed to lack of infrastructure facilities (slaughters, transport) as the driver of informal markets. There is also need to organize the market.
- iv. Lack of technology in the PVC: slaughter houses, cold chain, breeding centres, AI and semen production centres. There are only three (3) semen production centres across the country; this affects the choice of breeding decision and capacity of pig producers.
- v. Impact of Covid-19: Pig producers and processors have been deeply affected by Covid-19 pandemic. The main consumers of pig products are bars, restaurants and few individual clients. Since the Covid-19 outbreak and the start of lockdown in Rwanda (early March, 2020), bars are still not operational and pork meat price was revised downwards. However, animal feeds price has not reduced, therefore, some processors have shut down and are quit the business.

R-PFA recommends the GoR and its partners to support pig farmers by providing technical and financial means. This should be done by facilitating the engagement of private sector from production to processing. There is also a need to map all key players in the PVC so that their organization in cooperatives should be done to avoid informal business as it is the current situation.

#### **6. Input suppliers (Megavet)**

Megavet is a private company supplying veterinary services and inputs through importation. The main services that Megavet provides to pig farmers are provision of veterinary inputs such as drugs, vaccines, animal feeds and equipment. This is done through the collaboration with veterinarians who are the main clients of drugs and vaccines.

Megavet thinks that the engagement of private sector in the veterinary service provision should be done by transferring some government functions to the private sector but with provision of subsidies to farmers. Since there is no national vaccination plan for pigs, farmers do not have access to vaccines unlike dairy farmers.

#### **7. Slaughterhouse operators**

- a. Number of slaughtered pigs per month

Pig slaughter houses are not a common business in Rwanda. From all the places we visited, the majority of them are slabs (“*Tueries*”)<sup>33</sup> and is done on-farm slaughtering. The only slaughter house that had complied with all the statutory requirements was in Nyarugenge district (Kigali city). In this slaughterhouse, the monthly average number of pigs slaughtered was 720. For the slaughter slabs, the number of pigs slaughtered varied between 40 -300 pigs per month.

b. Price of live pigs and pork meat

Slaughterhouse owners said they do not pay for live animals, rather for carcasses. The prices of pork meat at the slaughter house vary from place to place. However, at the entry, the lowest price revealed was RWF 1,400/kg of the carcass (Gakenke and Musanze district), while the highest was RWF 1,900/kg (Rulindo district).

c. Value added pork products technology

Rugali Meat Processing Plant (Kigali city) is the only meat processing company that added value to pork, but also exported to Democratic Republic of Congo (DRC), with few individual buyers. The most common processing technology at almost all the slaughterhouses was pork meat cuts with very few making fresh sausages.

d. Markets and distribution

The price of pork meat at retail was also found to vary, with the lowest price of RWF 1,700/kg to 3,500/kg. The main customers of the pork meat are individual consumers, bars, supermarkets, hotels in the country and few regional markets (DRC).

Among the challenges identified by slaughterhouse operators were;

- i. Traditional slaughtering: it was revealed that animals are slaughtered on the ground and few slabs hung the carcasses afterwards. With these practices, it is likely that the quality of meat is very poor.
- ii. Impact of Covid-19: Rugali Meat Processing Plant reported that they are no longer processing pork meat since March, 2020 due to Covid-19 pandemic. Their main customer (export) was the RDC, however, since the outbreak the company has stopped its operations.
- iii. Access to finance: Since the majority of slaughterhouse owners are individuals or cooperatives with few members, it was found to be very hard for them to access to loans and

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<sup>33</sup> *Tueries* is a French name meaning animal killing places

microcredit. The actual financial mechanisms are informal via *tontines*<sup>34</sup> and other local savings models which are barely sufficient for large investments

- iv. Low supply in live pigs: Due to the informal slaughtering at farm level, pig slaughterhouses do not fully utilize their processing capacity, therefore leading to low income from this business.
- v. Environmental issues: The only waste management practice found at all the slaughter slabs was a pit in which all the wastes (solids and liquids) are channeled and left to decompose.
- vi. Lack of technology: Since pigs are traditionally slaughtered, there is less technology associated with meat processing. The only processing technique is the meat cuts (fresh cuts), no cold chain is applied.
- vii. Lack of traceability: in the current pig production system, farmers do not use tags or any other animal identification method.
- viii. Cultural perception towards pork meat: Since this is a new commodity in Rwanda, many people tend to attribute low value on pork meat and pig products.

## **5. Feed manufacturers**

### ***Case study: Huye Feeds Factory***

*Huye Feeds Factory is located in Huye District Southern Province, Huye Sector, Sovu Cell. Huye Feeds was constructed with Korean government support and handed to MINAGRI as a donation to improve livestock production. Huye Feeds Factory produces and supplies animal feeds for poultry, fish, pigs and cows. The factory was constructed to respond to the farmers' challenge in accessing a good quality and affordable animal feeds. The factory has a capacity of 100 - 200 Metric tonnes (MT) per day but it produces only 20 MT depending on the farmers' needs. The challenges facing the factory were as follows;*

- *Lack of technical skills for staff*
- *Price fluctuation of feeds in the market*
- *Climate change*
- *Location: The Huye Feed Factory is located far from Huye City*
- *There is no transport facilities for staff*
- *Lack of market for feeds*
- *Lack of enough clients to purchase feeds*

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<sup>34</sup> *Tontines*: French name, meaning an informal saving at community level

- *Client are unable to afford the high feeds prices*
- *Lack of information about market situation*

### **3.10 Factors that affect uptake of Technology in the piggery value chain in Rwanda**

Socio-economic and institutional factors that influenced technology adoption among pig farmers were identified under 3 categories; farmers' characteristics, participants perceptions and institutional factors. Farmers' characteristics included education level, gender, age, resource endowment and attitude towards risk. The farmers' perception about the complexity of the technology included the ease of access to the technology and availability of complementary inputs. Institutional factors included access to markets, infrastructure (roads, water, and market), services such as extension and communication technology and an enabling environment such as licensing. Technology was considered as any intervention that had a positive impact on production including breeds of breeder pigs, use of AI housing, health, feeds.

Pig farming experience was an important determinant of adoption of AI. This is attributed to the fact that farmers with more experience are able to detect heat in sows accurately<sup>35</sup>. Older farmers have a tendency to stick to what they are used to and therefore have lower technology adoption rates. Young pig farmers were also reported to have low AI adoption rates due to lack of finances<sup>20</sup>. Literacy levels also have a significant effect on adoption of AI technology. Smallholders with post-primary education were reported to have a higher adoption rate. Education is considered to be an enabler to technology uptake for two reasons; individuals that are more literate are able to interrogate and understand technical information regarding a technology better and secondly, the likelihood that such individuals have other sources of income that can support investment in technology.

Farmers' attitude towards risk also influenced uptake of technology. Farmers often participated in more than one farming activity so as to complement income from pig production. These farmers were therefore risk averse and had a lower adoption rate for technology.

Farmers' perception about technology was also a significant determinant of technology adoption. In the case of insemination choice and type of feed, the perception of high price and access to

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<sup>35</sup> Munyaneza et al. 2019. Factors influencing success of artificial insemination of pigs using extended fresh semen in rural smallholder pig farms of Rwanda. *International Journal of Livestock Production*, 10(4). DOI: 10.5897/IJLP2018.0562

cheaper alternatives negatively affected their adoption. Among the other factors that were identified during key informant interviews was the cost of AI which was beyond the reach of many farmers. The high cost was attributed to the long distance to the farms and a low number of trained inseminators. The complexity of technology was a significant determinant of technology adoption. Many farmers reported that they did not know how to use pre-formulated commercial feeds and as such did not use them.

Institutional factors that influenced technology adoption negatively included lack of infrastructure especially slaughterhouses, lack of extension and credit services. These factors play a significant role in investment decisions through reduction of participants' susceptibility and exposure to production and market risks.

## CHAPTER FOUR

### ENVIRONMENTAL ASSESSMENT OF THE PIG VALUE CHAIN

#### 4.1 Context of the assessment

The vision of the Pig Value Chain development roadmap of 2017/18-2021/22 states that the Rwanda pork industry must become an efficiently functioning sub-sector with a highly market-oriented farming, processing and dynamic marketing to supply consumers with high quality and safe pig meat/pork, while operating in a more sustainable way. Such a plan will undoubtedly focus towards closing the national gap in meat production and consumption, improve household food and nutritional security, achieve income growth and poverty alleviation and thus, will contribute in the growth of the national income<sup>36</sup>.

In the line of sustainable development in every economic sector, the Government of Rwanda (GoR) has set up Laws and Regulations requiring any activity to comply with the requirements of sustainable environmental use. Thus, according to the Organic Law, “Every government project or individual activity cannot be permitted to operate if they are in contravention of this plan and shall prioritise the strategies of conservation of the environment as provided for by law”<sup>37</sup>. Law No 48/2018 of 13/08/2018 on Environment states that “*Every socio-economic sector must mainstream environment and climate change in the development and implementation of its policies, strategies, plans and programs*”. Administrative entities, national and international non-governmental organisations as well as individuals must conserve the environment and prevent adverse effects of climate change<sup>38</sup> while initiating an economic activity.

Over the past two decades, various livestock development policies and initiatives have been developed aimed at promoting livestock production and enhancing productivity. The Government of Rwanda, through the National Industrial Research and Development Agency (NIRDA) therefore aims at achieving positive results across the industrial sector through improving competitiveness of existing industries and identifying new sub-sectors or value

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<sup>36</sup>Rwanda Livestock Master Plan, August 2017

<sup>37</sup> Organic Law No 04/2005 of 08/04/2005 determining the modalities of protection, conservation and promotion of environment in Rwanda, Art.31

<sup>38</sup>Law No 48/2018 of 13/08/2018 on Environment, Official Gazette No Special of 21/09/2018, Art.21.

chains, such as Pig Value Chain, where investment by the private sector would lead to export growth and import substitution. Provision of incentives to producers to improve production of quality products and enhancement of competitiveness of Rwandan small and medium sized enterprises are also enacted in the Rwanda Consumer and competition protection policy<sup>39</sup>.

Such development objectives in the Pig Value Chain need to be accompanied by an environmental impact evaluation report while in consideration of the various functions of the value chain; production, transport, slaughtering, selling and consumption.

#### **4.2 Objective of environmental assessment**

The overall objective of the environmental assessment of the current available technology in the piggery value chain in Rwanda is: a) to highlight strengths and weaknesses that should appear in the compliance with laws and regulations of environment protection and, b) to set out a comprehensive new environmental behaviour toward animals along all the stages of the pig value chain. The assessment will carry out a deep environmental impact assessment in the current state of pig value chain to clarify environmental and social standards and practices related to:

- a) Pig welfare in regards to appropriate environment including shelter and comfortable resting area;
- b) Pig transport with reference to avoiding distress, pain and injuries;
- c) Waste management from pig shelter or slaughterhouse for the protection of the surrounding physical and social environment;
- d) Hygiene in slaughtering areas or slaughterhouses;
- e) Safety of pork meat in trading shops supplying consumers.

#### **4.3 Guidelines for environment considerations**

It is necessary to consider animal welfare in general. That is the state of the animal in all circumstances. Protecting an animal's welfare means providing for its physical and mental needs. Thus, the treatment that an animal receives is covered by other terms such as animal care, animal husbandry and humane treatment.

Physical and mental needs for an animal also known as the animal freedoms include:

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<sup>39</sup> Rwanda Consumer and Competition Protection Policy, Ministry of Industry and Trade, 2010

- a) Freedom from hunger and thirst by providing clean water and well-balanced nutritious diet;
- b) Freedom from discomfort by providing a convenient shelter;
- c) Freedom from pain, suffering and injury by avoiding to hurt animal;
- d) Freedom to express normal behavior by providing suitable environment features;
- e) Freedom from fear and distress by showing humane behavior.

It is worth considering fundamental principles that govern environmental conservation<sup>40</sup> in the line with Piggery Value Chain development. That is:

a) Precautionary principle

The precautionary principle contributes to preventing or reducing the disastrous consequences of human activities on environment. Thus, activities considered or suspected to have negative impacts on environment must not be implemented pending results of a scientific assessment ruling out the potentiality of such impacts.

b) Principle of environmental sustainability

The principle of environmental sustainability makes sure that present and future generations enjoy equal opportunities from the resources. The right to development must be achieved in consideration of the needs of present and future generations.

c) Polluter pays principle

The polluter pays principle aims to deter activities impairing environment and punish any person who violates regulations. Any person who demonstrates behavior or activities that cause or which may cause adverse effects on environment is either punished or ordered to make restitution. If the restitution is not possible, he/she is also ordered to rehabilitate it.

d) Principle of cooperation

The principle of cooperation helps consolidate efforts towards the conservation of environment. The government through its environmental policy emphasizes the promotion of international cooperation. Authorities, national and international nongovernmental organizations, associations and private individuals are required to cooperate in protecting the environment.

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<sup>40</sup> Law No 48/2018 of 13/08/2018 on Environment, Official Gazette No 21/09//2018

#### **4.4 Current environmental status in Pig Value Chain**

A survey was executed all over the country (Kigali City, Northern Province, Southern Province, Eastern Province and Western Province) for 332 farmers through an adapted questionnaire completed with qualitative data collected from Focus Group Discussions and Key Informant Interviews so that a comprehensive environmental status should be established.

##### **4.4.1 Pig shelter**

Appropriate shelter is one of the pillars for the environmental welfare of the pigs. The shelter must accommodate boars, sows, piglets, gilts, barrows and pregnant sows in different compartments. Each compartment should be large enough to permit the accommodated pig(s) to move freely and have a comfortable resting area. Furthermore, the shelter must be covered to avoid negative impacts of extreme weather features.

According to the findings, three categories of pig shelters were observed:

- No shelter at all.

The pig spends the day tethered to a post. Thus, the pig suffers as a result of injuries inflicted by the rope often causing cuts on the soft skin while the pig moves around seeking for food. Along the night, the pig is enclosed in a small secondary house to avoid theft. In each situation, environmental issues of concern include; pollution of soil and water due to pig waste spread carelessly and risk of diseases for the family members who may be in close contact with the animal.

- Temporary shelter made from rafters

Often, the shelter is not covered and the earthen floor is continuously dug up by over accommodated pigs. The pigs are usually exposed to high temperatures in the daytime and very low temperatures at night leading to discomfort and low production. Pigs lie on the earthen floor which is often wet with their urine and stool. The shelter is rarely cleaned probably once or twice a month yet pig feed is placed on this waste. This results in a high incidence of diseases for the pigs. A demonstration of the shelter is shown on Figure 19.



**Figure 19 Pig shelter without roof**

- Solid wood or brick shelter

The shelter is covered with iron sheets or tiles and divided into compartments that accommodate pigs according to their stage of production as demonstrated in Figure 20 and 21. The floor is made of concrete and a trough fixed in each compartment to allow pig to feed comfortably. A drainage system is provided inside the shelter. This structure of housing pigs should be up-scaled to all farmers for more environmental care and to improve the performance of pigs as well as the welfare of the surrounding population.



**Figure 20 Representative improved pig shelter: roof with iron sheets or tiles**



**Figure 21 An improved pig shelter with brick walls and iron sheet roof**

These improved pig shelters that can be easily cleaned by washing with water. As a result, the level of inconvenience caused by surveyed piggeries will be imperceptible or low. The Southern province expresses more inconvenience probably due to the density of both population and piggeries with poor shelter structures.

i. Inconvenience caused by smell from the piggeries in the study areas

The inconvenience caused by smell from piggeries in Rwanda are classified as imperceptible, low, tolerable (medium) and strong. Results in Table 20 showed that out of 332 smallholder pig farmers, 303 (91.3%) reported that the inconvenience caused by smell from the piggeries is imperceptible while 17(5.1%), 3% and 0.6% reported that inconvenience caused by smell from piggeries is low, tolerable and strong respectively.

**Table 20 Inconvenience caused by smell from the piggeries in Rwanda**

<b>Rate of smell from piggeries</b>	<b>Frequency</b>	<b>Percent</b>
Imperceptible	303	91.3
Low	17	5.1
Tolerable (Medium)	10	3
Strong	2	0.6
Total	332	100

*Source: Computed from field survey, 2020*

ii. Inconvenience caused by smell from piggeries by Provinces

In terms of provinces, results from Table 21 revealed that in Kigali, both smallholder pig farmers reported that the cause the inconvenience caused by smell from piggeries is imperceptible and no

one has reported low, tolerable and strong smell respectively. In Southern Province, 88 % of small pig farmers reported that the inconvenience caused by smell from piggeries is imperceptible, while 2 % reported low, 8% reported tolerable and 2% reported strong smell respectively. In Western Province, 86 % of small pig farmers reported that the inconvenience caused by smell from piggeries is imperceptible, while 12 % reported low, 2% reported tolerable and no one reported strong smell respectively. In Northern Province, 95 % of small pig farmers reported that the inconvenience caused by smell from piggeries is imperceptible, while 3 % reported low and 2 % reported tolerable and no one of the respondents reported strong smell respectively. In Eastern Province, 97% of small pig farmers reported that the inconvenience caused by smell from piggeries is imperceptible, while 3 % reported low, no one of the respondents reported tolerable and strong smell respectively.

From the results, the majority of respondents reported that inconvenience caused by smell from piggeries was imperceptible. Smallholder pig farmers should keep the pig shelters clean, reduce emission of dust which harbours bad smell and remove manure to a long-term storage to minimize smell emissions.

**Table 21 Inconvenience caused by smell from piggeries by Provinces**

Level of inconvenience	Province											
	Kigali		South		West		North		East		Overall	
	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
Imperceptible	30	100	81	88	77	86	57	95	58	97	<b>303</b>	<b>91.3</b>
Low	0	0	2	2	11	12	2	3	2	3	<b>17</b>	<b>5.1</b>
Tolerable	0	0	7	8	2	2	1	2	0	0	<b>10</b>	<b>3</b>
Strong	0	0	2	2	0	0	0	0	0	0	<b>2</b>	<b>0.6</b>
Total	30	100	92	100	90	100	60	100	60	100	<b>332</b>	<b>100</b>

*Source: Computed from field survey, 2020*

#### **4.4.2 Waste management**

Waste along the Pig Value Chain mainly comes from pig shelters and slaughterhouses and from meat trading shops. Waste management constitutes a strong pillar for the protection and the conservation of the environment as recommended by Law No 48/2018 of 13/08/2018 on Environment in the following terms: “*Solid waste must be disposed of in appropriate landfill or in a waste processing factory for production purposes. The following acts in connection with*

*chemicals and waste are prohibited: 1° to pile, dispose of and dump waste on unauthorised public places or any other inappropriate places<sup>41</sup>.”*

Currently, waste in Pig Value Chain production is managed differently according to the level of farming. Smaller farms collect the wastes from the pigshed, and spread it immediately in their crop fields. Even though the amount from the small farms is insignificant, the negative impact should nevertheless be harmful for soil and ground water due to toxic waste particles still alive. The same considerations are taken toward rural slaughters that do not have an appropriate dump site as they operate in open air and often, at different places. For larger farms that have installed permanent pig shelters, pig waste is swept and collected in a basin or channeled throughout internal drains up to earthen containment structures dug around the pig shed. Bacteria then break down the waste aerobically to produce useful manure to spray onto crop fields. However, pig waste alone is not sufficient<sup>42</sup>. The recommendation is to compost pig excreta with garbage from the house and the yard<sup>43</sup> by turning it frequently and work at high temperature to kill micro-organisms such as *Escherichia coli*, *salmonella spp*, parasitic worms and other faecal organisms<sup>44</sup>.

Where a lot of water is used to clean pig shelters the waste flows into dung pits where it decomposes thereby reducing harmful smell that would otherwise bother neighbors. Such drainage systems are demonstrated in Figures 22, 23 and 24.

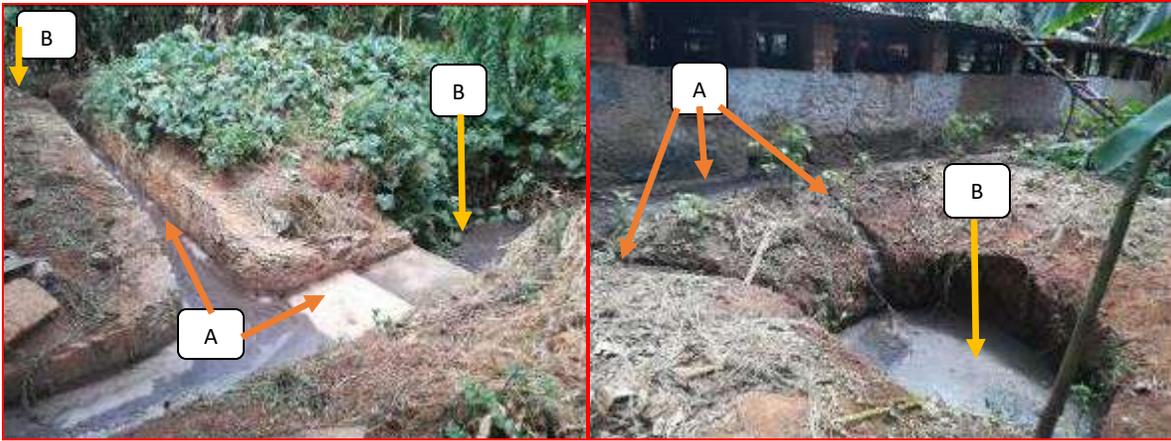
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<sup>41</sup>Law No 48/2018 of 13/08/2018 Art.18 and Art. 45 al 1

<sup>42</sup> Pig manure is toxic as pig feeds are high in a chemical called phytate which swine excrete as phosphorus. When farmers fertilize their land with pure pig manure, the phosphorus can become concentrated in the soil and back into ground water, harming aquatic life.

<sup>43</sup>Ingredients from dried grasses, dead leaves, kitchen scraps and pulled weeds.

<sup>44</sup>Such purified manure is helpful to the conservation of the environment as, once spread onto fields, it aerates the soil to allow roots to go through easier; it helps retain moisture and more over; it adds many nutrients needed by growing plants.



**Figure 22 Waste management channel and waste pit**



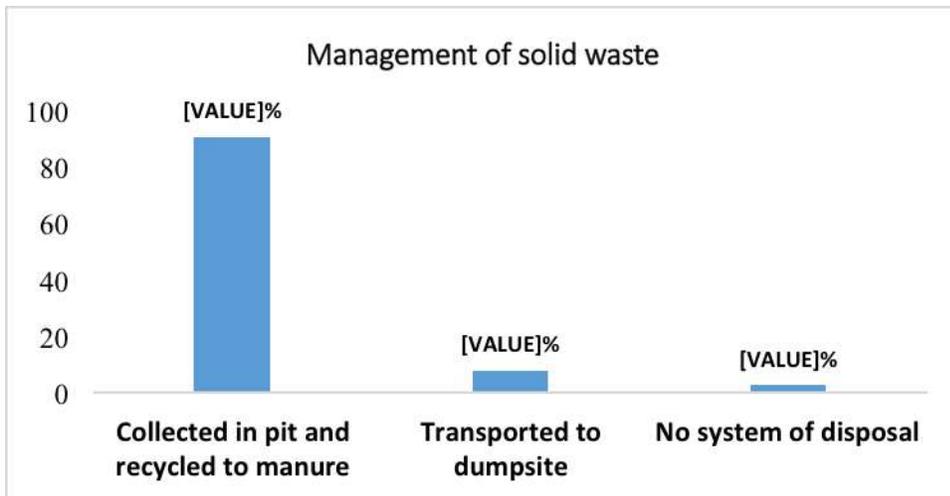
**Figure 23 Waste management – Bad (A) / Good external drainage (B)**



**Figure 24 Waste management – Dangerous no covered (A) / covered waste pit (B)**

The response to the question: “How do you dispose pig solid/liquid waste in your farm” confirms that most of pig farmers have at their disposal one or more waste pit used in provision of manure as a crop field fertilizer. Farmers who did not have an improved pig shelter to facilitate composting transported pig waste to dumping site or spread the solid waste in their fields.

In the current study, it was observed that solid and liquid waste were managed in different ways by smallholder pig farms. As shown in Figure 25, 90.1 % of smallholder pig farmers reported that solid waste are collected in pit and recycle to manure while 7.5 % of smallholder pig farming reported that solid waste are transported to dumpsite and 2.4 % reported that they do not have any system of disposal.



**Figure 25 Management of solid waste in pig farms in Rwanda**

Results in Figure 26 show that 89.8 % of smallholder pig farmers reported that liquid waste are collected with solid waste and recycled to manure while 7.2 % of smallholder pig farmers transported the waste to a dumpsite while 3 % did not have any system of disposal.



**Figure 26 Management of liquid waste in pig farms in Rwanda**

In many pig shelters, workers involved in feeding or cleaning did not have sufficient protective clothing as demonstrated in Figure 27. Such protective clothing is necessary to prevent or minimise exposure to zoonotic diseases such as salmonellosis, toxoplasmosis and campylobacteriosis. Such diseases can be prevented by use of safety precaution such as:

- a) Washing hands and clothes;
- b) Wearing boots, gloves and face masks;
- c) Covering any open wound when coming in contact with pigs.



**Figure 27 Incomplete Personal Protective Equipment for workers in pig shelter - Boots**

#### 4.4.3 Pig transport

Transport of livestock is undoubtedly the most stressful and injurious stage in the chain of operations between farm and market/slaughterhouse and contributes significantly to poor animal welfare.

The most appropriate and affordable method of moving pigs for many farmers is on hoof. Nevertheless, the hoof trekking must be chosen with the following conditions:

- a) Age of the pig. Weaned piglets are transported on shoulders by a person walking on foot;
- b) Distance from the farm to destination (market, slaughterhouse, relocation) must be short; otherwise, long distance travel without proper watering will result in severe dehydration thus, loss of weight and even death may occur;
- c) Moving early in the morning or late in the evening to avoid high sun heat that is seriously harmful for pigs.

By contrast, road motor transport is the method of first choice when the distance is long and the number of pigs huge. The weaned piglets are transported in a batched threecycle while sows and baors/barrows are conveyed within a batched truck. However, such means of transport and movement includes a lot of negative effects:

- a) Stress of pigs that leads to Pale Soft Exudative pork, meaning that the carcass will turn to bad quality;
- b) Bruising of inside skin due to the bounce of loaded animals. This constitutes the most insidious and significant production waste in meat processing;
- c) Trampling of pigs and suffocation due to slippery floor or overloading that does not permit a fair stand up;
- d) Heart failure due to overfeeding prior to loading and transport;
- e) Heart stroke due to extreme environment along the transport: temperature for adult pigs and humidity for piglets;
- f) Sun burn due to the exposure to sun heat in a long travel without proper watering or cover;
- g) Exhaustion that occurs mainly for weaklings or heavily pregnant pigs transported on a long distance;

- h) Injuries occurring mostly for broken legs due to inadapted truck floor or a fighting of pigs when the loaded vehicle stops a while.

From participant interviews, the most common causes of death of pigs in transit were as a result of wounds and exhaustion. The incidence was higher when pigs were pregnant or overfed prior to the trip since most of farmers moved their pigs on foot. The Northern Province experienced the highest losses due to the topography of the region (high mountains) and the distance to the markets as shown in Table 22.

**Table 22 Frequency of injuries on pigs during transport in Rwanda**

Injuries during transport	Province										Country	
	Kigali		South		West		North		East			
	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
Yes	1	3	7	8	10	11	31	52	4	7	53	16
No	29	97	85	92	80	89	29	48	56	93	279	84
Total	30	100	92	100	90	100	60	100	60	100	332	100

#### 4.4.4 Slaughtering area and slaughterhouse

A few low of modern slaughterhouses exist throughout the country<sup>45</sup>. Those abattoirs are exclusively supplied by authorized pig transporters who deliver large numbers of pigs per delivery. The rule is that pigs must remain unfed for 24 hours but with sufficient water supply before entering the slaughterhouse. To comply with International Animal Rights Organization's<sup>46</sup> requirements, pigs must be protected from suffering and killed humanely. Prior to slaughter, animals are walked up a raceway into the abattoir where they enter the stunning box. An operator stuns the animal to render it unconscious by electrical shock or carbon dioxide stunning and then immediately bleed the carcass by cutting the throat for meat quality reasons. Blood and other wastes are collected and conveyed to a dumping pit outside of the slaughterhouse. Floor and walls of the slaughterhouse are kept clean and the personnel wear appropriate clothes (apron, gloves, and rubber boots) to avoid contaminating meat. The meat is placed in a cold room or in a freezer to conserve its freshness from where it is delivered to butcheries.

<sup>45</sup>Rugali Meat Processing (Kigali), Base (Gakenke), Butare (Huye)

<sup>46</sup>Ref: [en.wikipedia.org/wiki/Environmental\\_impact\\_of\\_pig\\_farming](http://en.wikipedia.org/wiki/Environmental_impact_of_pig_farming)

However, in rural area where slaughtering equipment are not available, pigs are often killed inhumanely where the pig is stunned by striking it on the head with a heavy blunt object followed by a slit in the throat using a knife. This procedure is stressful on the pig and has an impact on the quality, shelf-life and processing qualities of the meat. A demonstration of a modern slaughterhouse with stunning area and a processing room is shown in Figure 28.

In informal slaughter, pigs are slaughtered in unhygienic conditions where banana leaves are spread on a wooden table or directly on the grass without a proper means of stunning. The butcher is frequently improperly dresses often wearing his usual dirty clothes. There is usually no water around to clean the pig after shaving. Therefore, pig meat distributed to consumers from those informal slaughtering sites is not safe even though, according to the law, the authorization is given and the sanitary inspection of fresh meat will have been carried out by a veterinary surgeon<sup>47</sup>. Very often, this meat spoils in few hours due to exposure to high temperatures under the sun and the unhygienic conditions since there are no means of conservation.



**Figure 28 Modern slaughterhouse at Rugali Meat Processing/Kanombe – Stunning room (A) / Meat processing room (B)**

#### **4.4.5 Butchery and pig meat selling places**

Pig meat is distributed to the consumers in two different ways, either directly from the slaughtering sites in rural area or from the butcher in cities and agglomerations. Thus, the safety

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<sup>47</sup> Ministerial Order No 012/11.30 of 18/11/2010 on Animal Slaughtering and Meat Inspection, Art.2, Art.3, Art.7, Art.9.

of meat is not ensured in rural area while it is in cities and agglomerations. Indeed, for butcheries in the cities and agglomerations such as Smart Butchery at Mutangana market (Nyabugogo), pig meat is supplied from agreed slaughterhouses and transported in appropriate vans from Base slaughterhouse<sup>48</sup>. The personnel that unload, transporting and sell meat in the butchery wear clean aprons. The district administration prescribes appropriate hygiene measures for butcheries to ensure public safety. These include the designation of places where meat can be sold, paving the place and flushing it out after each day work.

Therefore, extensive improvements must be undertaken to ensure meat safety in the rural areas where slaughter points double up as selling points with little regard to meat hygiene conditions. Figure 29 demonstrates a moderately improves selling point with washable surfaces and a cold storage facility for meat. However, the meat display section could be improved such that the meat is protected from too much environmental contamination including flies.



**Figure 29 Middle scale meat shop at Ruyenzi sub-urban area**

A demonstration of a modern butchery is shown in Figure 30 where a meat carrying crate is used to minimise human contamination of the meat, cold storage facilities, electric meat cutter, fully tiled walls and properly dressed personnel. These features are important in quality assurance of meat as well as improving the consumers' general perception on hygiene.

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<sup>48</sup>Visite of King Smart Butchery UMUNOPFU of Nyabugogo market place on 10/06/2020



**Figure 30 Modern butchery Umunopfu Meat Shop at Nyabugogo**

#### **4.5 Policies, regulations and laws**

The Government of Rwanda has enacted a number of regulations and laws that govern economic development and sustainable environmental management for economic activities including pig production. The Constitution of the Republic of Rwanda that was revised in 2015 ensures the protection and sustainable management of environment and encourages rational use of natural resources. Thus, an environmental law No 48/2018 of 13/08/2018, Article 3 states on the principle of precaution that *“the precautionary principle contributes to preventing or reducing the disastrous consequences on environment. Activities considered or suspected to have negative impacts on environment must not be implemented pending results of a scientific assessment ruling out the potentiality of such impacts”*. The Organic Law No 04/2005 of 08/04/2005 states that *“The establishment of national policy of protection, conservation and promotion of the environment is the responsibility of the Government of Rwanda. It (the Government of Rwanda) develops strategies, plans and national program aiming at ensuring the conservation and effective use of environment resources”*.

The Technology Audit of the Piggery Value Chain in Rwanda is submitted, among others, to the following Policies, Regulations and Laws:

- a) Constitution of the Republic of Rwanda (Revised), 2015;
- b) Economic Development and Poverty Reduction Strategy;
- c) 7 Years Government Program: National Strategy for Transformation, NST1 2017-2024;
- d) Vision 2020;

- e) Vision 2050 Aspiration, 2018;
- f) National Determined Contributions (NDCs)
- g) Green Growth and Climate Resilience Strategy;
- h) National Environment and Climate Change Policy, 2019
- i) Rwanda Strategy for Rwanda Meat Exports to DRC, 2016
- j) Rwanda Livestock Master Plan, 2017
- k) Law No 48/2018 of 13/08/2018 on Environment;
- l) Law No 54/2008 of 10/09/2008 determining the prevention and fight against contagious diseases for domestic animals in Rwanda;
- m) Ministerial Order No 012/11.30 of 18/11/2010 on animal slaughtering and meat inspection;
- n) Ministerial Order No 013/11.30 of 18/11/2010 on transport and trade of meat.

#### **4.6 Environment and Social Management Plan (ESMP)**

Any human development activity impacts undoubtedly on the environment components, either positively or negatively. The ESMP is therefore an instrument that should guide operators for a sustainable development in compliance with the equilibrium of the environment requirements. Such an instrument indicates the source of an impact, the characteristics of the existing or foreseen impact (impact character), how the impact can be reinforced or mitigated to conserve safe environment (enhancement/mitigation measures), who is responsible for the application of the measure (responsibility) and the external costs for the operator (costs).

An Environmental and Social Management Plan for the execution of the Technology Audit of the Piggery Value Chain in Rwanda is presented in Table 23.



**Table 23 Environment & Social Management Plan for the Piggery Value Chain development**

Stage in chain	Source of impact	Impact status	Measures	Responsibility	Cost	
Approval of Piggery Value Chain audit	Execution of PVC recommendations	Creation of new jobs	Enhancement of women & youth employment	Farmers, Entrepreneurs, Government	-	
Pig rearing	Lack of food & water	Suffering from hunger and thirst	Access to balanced diet and clean water	Farmers	-	
	Exposure to extreme weather & density	Discomfort	Appropriate shelter	Farmer	-	
	Dirty floor with excreta	Discomfort and pig diseases	Brush up and wash up	Farmer	-	
			Drainage system throughout the pig shelter	Farmer	-	
			Veterinary intervention	Veterinary services	-	
	Waste spread carelessly anywhere	Pollution of soil and water  Evil-smelling	Workers' contamination by E. coli, salmonella and parasitic worms	Personal Protecting Equipment (Boot, gloves, apron, face mask)	Farmer	-
			Construction of collection waste pit	Farmer	-	
			Recycling pig waste by composting for useful manure	Farmer	-	
Pig transport	Infected pig	Diseases transmission to pigs	Request of authorization	Sector authority	-	
			Sanitary control	Veterinary	-	
	Extreme environment features	Stress, dehydration, sun burn, heart stroke	Trip early morning or late evening	Entrepreneur	-	
	Overloading, inappropriate means	Pain, bruising, injury	Control of capacity and quality of vehicle	Entrepreneur	-	
Pork processing	Inappropriate place	Disease transmission to communities	Request of authorization for animal slaughtering	District authority	-	
	Infected pig	Disease transmission to communities	Sanitary control	Veterinary services	-	
	Dirty slaughtering points	Disease transmission to communities	Standardized infrastructures as of Min. Order No 012/11.30 of	District authority	-	

			18/11/2010, Art. 6 - 7		
	Dirty meat transport means	Disease transmission to communities	Respect of Min. Order No 013/11.30 of 18/11/2010, Art. 2 - 4	District authority	-
	Waste	Disease transmission to communities	flushing out the slaughter place after each slaughter, burying intestines and other remnants	Slaughter place owner	-
Pork trading	Inappropriate location	Disease transmission to communities	Request of authorization	Sector authority	-
	Inappropriate infrastructure	Disease transmission to communities	Standardized infrastructures as of Min. Order No 013/11.30 of 18/11/2010, Art. 6 - 8	Sector authority	-
	Poor hygiene at the trading place	Disease transmission to communities	Respect of Min. Order No 013/11.30 of 18/11/2010, Art. 10 - 12	Sector authority	-
	Poor hygiene of the personnel	Disease transmission to communities	Clothing aprons, special hats made of washable white canvas and shoes.	Sector authority	-

## **CHAPTER FIVE**

### **DISCUSSION**

#### **5.0 Introduction**

This chapter discusses results on the currently available technology with the objective of examining the potential for up-grading, extending and optimising them. Cross-cutting issues including gender and youth inclusivity, climate change and decent work are discussed. Implications for policy are discussed and proposals for policy given

#### **5.1 Technologies currently available to actors in the pig value chain**

This section discusses technologies applied by value chain actors to achieve specific outcomes that have a positive impact on pig enterprise performance.

##### **5.1.1 Production systems technology**

There were mainly 3 production systems that were recognised in this study which included the extensive, semi-intensive and intensive systems. Backyard tethering system was also observed; however, this system is more often than not injurious and stressful to pigs. As such, the system is not discussed.

###### **a) Intensive systems**

This study showed that intensive systems were most efficient. There are obvious benefits of this system mainly because it is easier to control and monitor pigs with reduced incidence of disease. Farmers are also able to monitor feeding and provide care to young piglets thereby reducing pre-weaning mortality. Piglet survival and disease incidence are key determinants of performance.

Intensive systems afford pig enterprises the opportunity to manage production planning so as to produce for a specific market; farrow to wean for sale of piglets, wean to finish for finishing weaned piglets or a farrow to wean system. The GoR could focus on supporting up-grading of semi-intensive systems since there is growth potential in these systems. The system is ideal for smallholder farmers due to the low requirement for land.

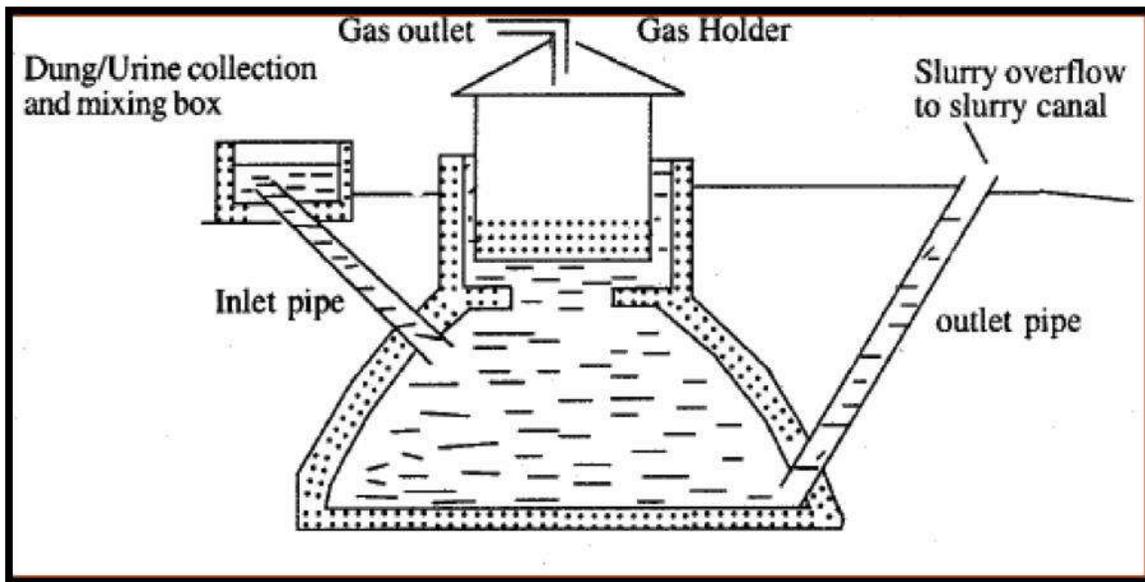
Intensive systems have the advantage of allowing for an environmental conservation programme through controlled management of effluent and possible recycling for use as manure and biogas production. These are usually impractical with extensive systems and only partially practical in semi-intensive systems. Potential technologies that can be used in intensive systems include:

i. Automated systems

Artificial intelligence, use of robots and sensors are some of the innovations applied in animal feeding. Sensors similar to ‘Fitbits’ in the form of wearables are creating a lot of interest in the pig industry. They can provide a solution to data collection by allowing farmers to track animals on an individual basis and monitor health in real time. Sensors can alert farmers about illness concerns, heat cycles, feed and water intake. Likewise, fixed sensors can record house ammonia levels, dust, humidity and temperature. Automated feed and water dispensers are common applications in pig production. Currently, a semi-automatic watering system is in use at Kisaro pig breeding centre. This mechanical device can be fully automated to facilitate feeding animals thereby significantly reducing the cost of labour.

ii. Potential for biogas production

Biogas is a combination of gases produced during anaerobic decomposition of organic materials including animal waste (dung, urine and waste feed). The main gaseous by-product is methane with low amounts of carbon II oxide ( $\text{CO}_2$ ), Ammonia ( $\text{NH}_3$ ) and hydrogen sulphide ( $\text{H}_2\text{S}$ ).



**Figure 31 Floating drum biogas plant**

(Source: KARI Technical note No 10. 2003)<sup>49</sup>

Methane is highly inflammable with a high amount of energy released upon combustion and hence it's potential as a household energy source. The system constitutes an underground

<sup>49</sup> Karanja and Kiruiro , 2003. KARI Technical Note No 10 on Biogas Production. KARI Technical Note Series

digester, an inlet and outlet pipe for slurry and an outlet pipe for gas as demonstrated in Figure 31. An alternative to this plant system is the Tubular Plastic Bio-digester.

Among the benefits of biogas systems are;

- A source of cheap energy
- Environmentally friendly by conserving trees used as firewood and reducing methane emissions
- It is a gender sensitive in that it reduces the time spent by women in search of cooking fuel (firewood) and also promotes their health by reducing smoke in kitchens
- The slurry is nutrient rich and safe to use

iii. Cost of bio-digesters

The main challenge with adoption of biogas plants is the initial cost of construction of the plant. In Kenya, the cost of construction varies between USD 500 – 800 depending on the model. However, farmers have been supported through government programmes in collaboration with development partners to support the bottom of pyramid.

The Tubular plastic bio-digester is however cheaper and was estimated to cost on average USD 55<sup>34</sup>. Care needs to be taken to avoid rupturing the plastic tube since it is installed on the ground surface. The pit digesters however generate higher gas pressure and are more durable than the tubular plastic bio-digesters.

**b) Semi-intensive systems**

Semi-intensive systems have the advantage of being less labour intensive compared to the intensive system. The requirements for pig feeding are also less demanding since pig are partly left on open paddocks to graze. The major limitations to this system include the larger requirement for land, extra expense for paddocking and lack of proper supervision for mating. This system is not ideal for smallholders due to the land size owned. Technological innovations in this system would include:

- Use of breeds adapted for pasture performance
- Use of electric strands as boundaries for paddocks as opposed to entire fences which are easily destroyed by pigs
- Use of nutrient dense supplementary feeds

**c) Extensive system**

This system requires vast tracts of land which is a limitation for majority of farmers in Rwanda. The system as is currently practiced has a number of disadvantages including; ease of spread of infectious diseases, high incidence of zoonotic cysticercosis, poor nutrition and lack of individual supervision of pigs. As a result, such systems are characterised by low productivity due to high incidence of disease, low fertility and inbreeding.

### **5.1.2 Technologies for improvement of pig breeds.**

There are mainly three technologies in use by pig farmers in Rwanda to up-grade their pig herds genetically. These include:

- Cross-breeding by introducing breeding sow-stock purchased from other farmers or breeding farms
- Cross-breeding by using boars obtained from neighbours
- Artificial insemination using semen from imported boars

Discussions with authorities in the field of animal health and animal production in RAB confirmed that there were obvious challenges with purchasing breeding stock from neighbours or using neighbours' boars for mating. There were high levels of inbreeding with possible effects of heterosis. The genetic make-up of the breeding stock was also not known making it difficult to use them in a genetic up-grading programme. It was however noticeable that farmers had made an effort to improve the breed of pigs they kept. This was observed in semi-intensive systems where there was a transitory mix of pig breeds.

The existence of a high population of indigenous pigs cannot be ignored considering that they have been kept by these farmers for a long time. These pigs are preferred for reasons ranging from adaptability to the environment, hardiness, more tolerance to disease and high temperature, lower demand for feed among others. This proposes an evaluation of the adaptations of indigenous breed to establish if their genetics could be used to develop a pig breed that is highly producing yet adapted to the local environment.

Each of the different breeds of pigs available in Rwanda had unique characteristics which are key in informing breeding programmes. These characteristics are summarised as follows:

#### **a) Landrace**

This breed constitutes the highest proportion of exotic breeds of pigs in Rwanda (37.7%)<sup>9</sup>. It is white in colour and has long ears pointing to the front. The breed has superior growth rate and

high-quality carcass with a large size with a long body and strong legs. They have many teats (more than 12) and can litter up to 14 piglets. They are adaptable to local weather.

**b) Large White or Yorkshire**

This breed was reported to constitute 22.9%<sup>9</sup> of pigs in Rwanda. The breed is white in colour with upright ears, has a large size but short in length. They have good mothering ability, large litters of up to 16 piglets and fast growth. This breed is therefore important very commonly used in piglet multiplication and breeding gilts production units.

**c) Pie train**

This breed constitutes 7.3%<sup>9</sup> of pigs in Rwanda. The breed is of medium size and is white with black spots and short legs. The breed has a broad back with good muscling with a high lean: fat ratio. Though the sows are prolific, they lack good mothering ability.

**d) Duroc Jersey**

Duroc Jersey pigs constitute 1.6 %<sup>9</sup> of pigs in Rwanda. The breed is dark red in colour, has fast growth rate, good mothering ability. It is popular in breeding programmes as a terminal cross for production of porkers due to the desirable carcass qualities and fast growth.

**e) Indigenous pigs**

These pigs are adapted to locally available feeds and local climatic conditions and therefore are cheap to rear. They are resistant to diseases and are often aggressive. They take long to mature, have low litter size (5 – 8 piglets) and have 8 - 10 teats. They have hard skins, low carcass weight and high fat content in pork.

Artificial insemination technology in pig production is widely used in many countries of the world. In the developed countries such as USA, Belgium, Germany and China, the rate of use of AI in pig herds varies between 50 and 80%. This has allowed pig industries to evolve to very efficient breeds of pig and reduce the cost of production. AI allows for faster dissemination of superior genetics since the boar to sow ratio can be as low as 1: 100 compared to conventional systems that require a ratio of 1: 10.

**i. Artificial insemination, breeding decisions, capacity and projections**

There are only three established semen production centres across the country; the University of Rwanda in partnership with RAB (Musanze), Kisaro breeding centre (Rulindo) and Muyumbu semen production centre (Rwamagana) as shown on Figure 1. Pig semen is manually collected

from identified, selected and trained boars. The quality of semen is evaluated for compliance to the Standard Operating Procedures (SOPs) in the semen centre laboratory. The semen is extended and stored at 17°C for a maximum time of seven days. The minimum number of doses (1 dose = 100ml) produced per boar/month was 40 doses while maximum production was 80 doses. A single dose is sold at RWF 5,000 with additional cost of insemination service and transport which adds up to RWF 15,000 per service. When sows are inseminated at the right time, the conception rate is higher (95%) than in cattle (64%), however the success rate requires the strong collaboration between farmers (to accurately detect heat) and inseminators (to access to the farm at the right time).

The semen production industry is very profitable; however, some challenges have been revealed to hinder its success:

- a) Low demand of semen: pig farmers are not aware of the benefits of the Swine Artificial Insemination, thus reducing the demand of the semen.
- b) Technology requirements: since semen production requires high technology inputs, interviewees said that they need technical support from the government or any other agency supporting PVC in Rwanda.
- c) Few trained inseminators: Since the centres are few and new in the business, few inseminators have been trained. For example, Kizaro breeding centre has trained 30 technicians since 2014 while UR/RAB have trained around 83 technicians between 2014 and 2019.
- d) High feed cost: It was found that boars' maintenance cost was high since the price for feeds is also high; it was revealed that 1kg of feeds costs RWF 400.

## **ii. SWOT analysis of the genetic resources and improvements in the piggery value chain**

Animal genetic resource refers those animal species that are used, or may be used, for the production of food and agriculture, and the populations within each of them. These populations within each species can be classified as wild and feral populations, standardised breeds, selected lines, varieties, strains and any conserved genetic material<sup>50</sup>. The pig genetic resources available

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<sup>50</sup>WORKING DEFINITIONS FOR USE IN DEVELOPING COUNTRY REPORTS AND PROVIDING SUPPORTING DATA

<http://www.fao.org/3/y1100m/y1100m03.htm>

in Rwanda includes standardised breeds (Landrace, Large white, Pietrain and Duroc Jersey) commonly found in intensive systems and breeder farms and indigenous pigs and their crosses commonly found in extensive and semi-intensive systems. Following is a SWOT analysis of available genetic resources.

### **Strengths**

- Diverse genetic resource base which could be used to develop breeds that are adapted to the local environment
- Presence of 3 breeder studs from which an extension plan can be developed
- Local technical expertise in training boars for semen harvesting, semen evaluation and extension
- High conception (95) rates of existing AI services
- Availability of AI services increases the rate of dissemination of improved genetics
- Availability of human resource that can be used in capacity building for AI service providers
- Large population of sows which provides a critical mass of dams for multiplication
- Preference for pig farming over other ruminant livestock due to land constraint

### **Weaknesses**

- Low population of pure-bred sows with no known genetic make-up
- Low productivity of smallholder enterprises limiting their ability to increase investment
- Low demand for boar semen due to high cost

### **Opportunities**

- Increasing demand for efficient breeds of pigs to meet production targets
- Increased demand for pork for domestic consumption and also for export
- Growth of the private sector for input supplies
- Increased GORs efforts in commercialisation of Agriculture and strengthening of agricultural value chains
- Declining role of agriculture in major economies creating markets for food commodities from developing countries
- Expanded access of internet services from which farmers can obtain relevant information

### **Threats**

- Pig diseases
- Fluctuation of feedstuff prices and quality
- Poor access to AI technology
- Low literacy levels which have a negative impact on technology adoption
- Environmental concerns owing to the terrain and also increase in emission of greenhouse gases.

### **5.1.3 Technology in pig feed production**

Good quality feeds are critical in commercial pig production because of the interaction of feeding with many performance parameters. Pigs being monogastric require low fibre diets since they do not produce cellulase, an enzyme necessary in breaking down dietary fibre. Only a limited amount of fibre digestion takes place in the caecum and large intestines by resident anaerobic bacteria in older pigs. Therefore, pigs require easily digestible, energy rich and amino acid specific diets.

Though there are a number of feed milling companies in Rwanda, it was reported that they are lacking in technical capacity. Many of those farmers who prepare home-made feeds have no technical knowledge in pig feed preparation. The possible outcome is that the feeds have nutrient imbalances and deficiencies which has an impact in the performance of pigs and quality of meat. It would therefore be important to ensure that any pig development programmes go hand-in-hand with building technical capacity in pig nutrition and feed formulation.

### **5.1.4 Technology in Animal recording**

The significance of animal recording is twofold. It allows for precision management of pig herds and secondly it is critical for establishing traceability systems. Most pig farmers in Rwanda identified their pigs by their appearance, colour or names. This system is often not reliable since there is a likelihood of duplication of names and pigs of the same colour and appearance. The turnover of pigs in farms is also much higher compared to other livestock rendering such identification systems untenable.

The current situation presents an opportunity for developing digital pig management systems which could be linked to breeding studs to create a database of available genetics. This would also be useful in establishing a traceability system for Rwanda's pork making it attractive in the

export market. It was worth noting that up to 40% of pig farmers have access to the internet creating a potential innovation platform for digital recording of pigs.

Herd registration and whole litter records would be the most ideal form of animal recording for the following reasons:

- i. Individual recording may be too expensive and tedious to implement
- ii. Pigs have short life cycles and therefore, pig enterprises may end up with large volumes of obsolete records

### **5.1.5 Technology innovations and interventions in pig marketing**

In Rwanda, majority of pigs are sold as live animals and slaughtered for meat with limited or no value addition. Proposed technologies that offer the opportunity to improve marketing would include the following:

- i. Digital sensors are creating a lot of interest in the pig industry and allow small farmers to track animals on an individual basis and monitor health in real time. Sensors can alert small pig farmers on onset of heat (estrus), illness, and food and water intake thereby promoting precision herd management.
- ii. Use of collective marketing and improving bargaining power in the market to increase small farmers' effort to upgrade either vertically or laterally into other higher value functions.
- iii. Pig smallholder farmers should improve the structure of pig industry to improve their participation in every stage of the value chain such as specialized transport and access to market information.
- iv. Improvement of pig markets and to reduce markets prices could contribute to enhance production in different areas of Rwanda.

### **5.1.6 Technology in pork and pork products consumption**

- i. Overview of pork consumption

Inspite of religious and cultural concerns, pig production, processing and consumption have gained importance as a source of employment and household income and food security. Results from FGD and KII showed that majority of pig farmers also slaughter pigs for domestic consumption while some is sold or given to neighbours. Pork is therefore key in addressing protein nutrition deficit in Rwanda. According to UNICEF, though Rwanda has made significant progress in addressing malnutrition, the incidence of stunting in children is

still relatively high at 38%<sup>51</sup>. Rwanda's nutrition policy recommends support for income generating activities at the household and cell level, in particular, for women<sup>52</sup>. This is based on the fact that income generated for women will to a great extent be spent on buying food and food items that are not produced in kitchen gardens such as fruits. This contributed immensely to improving household nutrition status.

The most commonly found processed pork products in supermarkets were sausages and bacon. Random interviews of customers in supermarkets indicated that majority had no knowledge of other products apart from sausages. Many of these clients expressed a liking for sausage but did not purchase them frequently because of the perceived high cost. Sausages were also served in hotels particularly so, those in the high end. Most of the processed pork products are exported to neighbouring DRC where the demand is unmet.

Most of the pork consumed at home came from home slaughter. Most consumers of this pork felt it is affordable and easily available. There appeared to be little concern about slaughter hygiene. Likewise, most of the pigs slaughtered at home were generally small owing to the fact that these were preferred to avoid losses from spoilage since there were no storage facilities.

#### ii. Value addition to pork and impact on consumer price

The government of Rwanda is now collaborating with the private sectors for increasing investment in the pork meat industry to improve value addition and diversification into high value products. There was evidence that value addition to pork increased incomes of traders. Pork cuts commonly practiced in butcheries increased pork value by approximately 50% while cooked pork commonly found in bars contributed a further 10 – 20% increase in the value of pork

#### iii. Technology gaps at the retail level

There are several technology gaps at retail level that hinder the delivery of a wholesome product to the consumer. Though there are strict hygiene standards stipulated by the GoR concerning meat handling and storage, consumers are often exposed to food-borne illnesses arising from meat contamination with disease causing micro-organisms. Technology gaps include lack of cold

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<sup>51</sup> UNICEF Rwanda Reports. <https://www.unicef.org/rwanda/research-and-reports>

<sup>52</sup> National Nutrition Policy, 2005. Ministry of Health, Rwanda. <https://extranet.who.int/nutrition/gina/sites/default/files/RWA%202005%20National%20Nutrition%20Policy.pdf>

chain facilities, excessive handling of meat with bare hands, lack of adequate protective clothing for butchery employees, lack of specialised or electric meat and bone cutting equipment. Lack of water in some facilities and improper packaging aggravate the situation.

### **5.1.7 Technology interventions for access to microfinance services**

Financial service providers operate in financial system that is often considered underdeveloped. Credit markets in Rwanda are still limited for smallholder farmers and informal industry players due to the high-risk nature attributed to them. Majority of these actors rely on informal services like ‘*ibimana*<sup>53</sup>’ and informal financial institutions that provide small loans to individuals. Very few farmers have bank accounts. Pig farming is considered risky due to the incidences of serious diseases epidemics that can easily spread across herds. Recently, there has been considerable improvement of financial services among smallholder pig farmers with introduction of the following services;

- i. -Use of mobile money transfer and microfinance services.
- ii. -Several Savings and Credits Cooperatives (SACCOs) have been established by the Government of Rwanda to encourage rural people to access financial services to boost their income.
- iii. -Formation of pig farmer’s cooperatives which makes it easy to get credit from microfinance institutions for improving pig production and to access markets for their pigs.

### **5.1.8 Proposed ICT interventions in the piggery value chain**

Currently, the use of ICT among players in the value chain is limited to voice communication and obtaining technical information using mobile phones as well as audio-visual mass media for extension information. This study would propose both short term and long-term ICT interventions in the PVC as follows;

In the short term,

- i. -Creation of market information websites with current updates on information on pig prices in various markets. This would help to send price signals to pig farmers.
- ii. -Use of interactive radio programmes of various aspects of pig production with professionals to handle farmers’ questions
- iii. -Demonstration of pig farming practices on television

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<sup>53</sup> *Ibimana* is a Kinyarwanda name for *tontines*

- iv. -Use of leaflets, brochures, pamphlets and newspapers to communicate with actors in the value chain. This approach has been effective in Kenya with a weekly magazine ‘Seeds of Gold’ which is circulated in one of the newspapers with national distributorship.

In the long term,

- v. -Geo-mapping of pig farmers and other players in the industry will be useful in enhancing traceability of pork and pork products

#### **5.1.9 Proposed technology interventions for improving access to inputs and services**

The GoR is committed to improving access to inputs and services to agricultural enterprises so as to improve efficiency and become market oriented. As such, the government aims at supporting growth of the private sector to offer complimentary services to through commercialisation of such services. Rwanda is well known for its advances in use of IT in delivery of medicines to hospitals in far flung parts of the country using guided drones. Such technologies can be built upon to enhance delivery of inputs including boar semen for AI services. However, this study proposes the following technology interventions for improving access to inputs and services;

- i. Creation of websites with contacts and location of professionals (veterinarians and other animal health practitioners) in conjunction with relevant professional regulatory bodies and professional associations. Farmers and other value chain actors will easily get in touch with a professional and obtain services.
- ii. FFS and piggery business hubs would enhance access of inputs and credit to rural farmers
- iii. Creation of websites with a database of input suppliers and the inputs supplied
- iv. Creation of mobile phone application that aid farmers in carrying out husbandry practices
- v. Establishment of virtual warehouses where farmers can buy inputs and pay using mobile money applications
- vi. Virtual sector specific membership groups where actors can engage professionals

#### **5.2 Institutional and policy environmental effects on technology adoption in the piggery value chain in Rwanda**

Key policy concerns in the agricultural sector in Sub-Saharan Africa target issues associated with productivity and household incomes, enhancing food security, encouraging private sector investment and promote environmental sustainability. Presence of effective and efficient institutions is critical in delivery of these objectives. The analysis in Table 24 provides a broad

evaluation of the institutional and policy framework that supports dissemination of technology in Rwanda directly and indirectly.

A review of information available on the institutional and policy framework shows concerted effort in supporting industry players to achieve their goals. A few challenges are however notable such the duplication of roles as was reported in the strategy paper on the National Policy on Cooperatives in Rwanda<sup>21</sup>. Likewise, there is a possibility of overloading institutions as is the case with the Rwanda Standards Board which is tasked with inspection of animal feeds for quality, inspection and certification of slaughter facilities, meat hygiene, weights and measures and packaging quality among other functions which is likely to result in functional and technical inefficiency.

### **5.2.1 Role of the private sector in dissemination of technology**

The private sector plays a significant role in technology dissemination particularly so in ICT. The National ICT strategy for Rwanda Agriculture (ICT4RAg)<sup>54</sup> offers critical support to rationalize and optimize financial, human and institutional resources and harness opportunities to address challenges in the agricultural sector. The strategic plan recommends an expanded private sector role in ICT adoption, adaptation of available innovative ICT solutions, and results-based monitoring and evaluation. To ensure sustainability of implementation of this strategy, active use of innovative project financing models including; Public-Private Partnership (PPP), Challenge Funds, Endowment Funds, Venture Capital, Seed Capital have been proposed to attract private sector investment. One of the Key Performance Indicators of this strategy suggests that private sector investment in agriculture will increase from 5% to 15%.

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<sup>54</sup> MINAGRI, 2016. The national ICT strategy for Rwanda Agriculture (ICT4RAg), 2016 – 2020.

**Table 24 Institutional and policy framework that supports technology dissemination and use in the piggery value chain in Rwanda**

Technology	Implementing agency	Function	Policy framework
<b>Production function of the value chain</b>			
-Improved breeds -Artificial insemination -Digital livestock recording -Improved pig housing (Animal welfare)	MINAGRI	Industry regulation, inspection and certification, information management	-PST -LMP, 2017 <sup>5</sup>
	RAB/ Rwanda Animal Resources development agency	Implementing agency for MINAGRI -Data management	
	Artificial insemination centre	Ensure availability of quality germplasm	
Improved animal feeds	MINAGRI	Regulation and registration	HACCP, GMP
	Rwanda Standards Board	-Establishing quality standards -Compliance testing and certification	
-Environmental conservation	MINAGRI Ministry of Environment	-Provide technical support and training -Environmental audit	Refer to Chapter 4
<b>Marketing function of the value chain</b>			
-Use of ICT platforms for marketing	-RAB -MINICOM -Ministry of ICT and Innovation -Private sector	-Promote access to internet services -Promote innovation platforms -Regulation	National ICT policy and plan 2001-2005 <sup>55</sup> National Information and communication plan <sup>56</sup> - ICT4Rag
-Organised marketing	-MINICOM	-Support producer marketing organisations	National Policy on Cooperatives <sup>57</sup>
<b>Processing, distribution and product quality control function</b>			
-Modernised slaughter and processing	MINAGRI/Ministry of trade/ NIRDA/ GOR -Public health department -MINICOM	-Design -Inspection and certification -Infrastructure (water, electricity) support -Issue health certificates to slaughterhouse	HACCP, GMP, ISO, OIE -Strategic and Investment Plan for Rwanda Meat Industry (2012) <sup>58</sup>

<sup>55</sup>National ICT policy and plan 2001-2005 [https://minict.gov.rw/fileadmin/Documents/Rwanda\\_ICT\\_Policy\\_NICI\\_2005.pdf](https://minict.gov.rw/fileadmin/Documents/Rwanda_ICT_Policy_NICI_2005.pdf)

<sup>56</sup>National Information and communication plan 2015. [https://minict.gov.rw/fileadmin/Documents/Rwanda\\_NICI\\_2015.pdf](https://minict.gov.rw/fileadmin/Documents/Rwanda_NICI_2015.pdf)

<sup>57</sup> National Policy on Cooperatives, Ministry of Trade and Industry.

[http://www.rca.gov.rw/uploads/media/2019\\_03\\_20\\_Cooperative\\_Policy\\_ENGLISH\\_5.pdf](http://www.rca.gov.rw/uploads/media/2019_03_20_Cooperative_Policy_ENGLISH_5.pdf)

		workers	-HACCP and standards for meat processing and handling -OIE regulations
	RSB -Private sector	-Certification of processed pork products -Inspection of compliance	
-Specialised vehicles for transport of live pigs -Specialised meat carriers	MINAGRI	-Licensing of carriers -Enforcement of meat hygiene standard, residues in pork	
	RSB	-Inspection and certification	
Waste disposal and waste water recycling	-Ministry of Environment	-Plant inspection and certification -Environmental audits	See Chapter 4
<b>Wholesale and retail functions</b>			
-Packaging -Sanitation	-Ministry of health -Public health department	-Enforce hygiene standard -Licence meat handlers	-HACCP and standards for meat processing and handling
	DVS, RBS	-Chief meat inspector -Prevention, control & eradication of zoonotic diseases	Law N° 54/2008 Determining the Prevention and Fight against Contagious Diseases for Domestic Animals in Rwanda -OIE regulations
	-RSB, MINICOM	-Standardisation of weights and measures	Rwanda Quality Policy <sup>59</sup>
	-MINICOM	-Licencing of traders	Law No 39/2010
Competition and fair trade practices and trade	-MINICOM -National Agricultural Export Development Board (NAEB)	-Promote value addition	

<sup>58</sup> Strategic and Investment Plan to strengthen the Meat Industry in Rwanda. Ministry of Agriculture and Animal Resources. [https://www.minagri.gov.rw/fileadmin/user\\_upload/documents/STRAT.PLC/Final\\_report\\_Rwanda\\_Meat\\_industry\\_final.pdf](https://www.minagri.gov.rw/fileadmin/user_upload/documents/STRAT.PLC/Final_report_Rwanda_Meat_industry_final.pdf)

<sup>59</sup> Rwanda Quality Policy 2010. Ministry of Trade and Industry. [http://www.rsb.gov.rw/fileadmin/user\\_upload/files/RQP.pdf](http://www.rsb.gov.rw/fileadmin/user_upload/files/RQP.pdf)

### **5.3. Strategic objectives and policy options to increase competitiveness of the piggery value chain**

The ability of an enterprise or organisation to remain competitive can be assessed using the Porter's Five Forces of Competitive Position framework developed by Michael Porter in 1979<sup>60</sup>. The framework postulates that there are five forces that determine the attractiveness of a product in the market. The five forces help to identify where power lies and therefore the source of competitive advantage. These five forces are; supplier power, buyer power, competitive rivalry, threat of substitution and threat of new entrants. These five forces are useful in identifying strategies to improve competitiveness and were applied in this study to evaluate competitive position.

- i. *Supplier power*: Majority of pig farmers are small scale producers with low level of organisation. As a result, purchases of inputs are done individually and in small quantities. Producers therefore have little or no influence on the cost of inputs such as feeds, drugs and animal health services. Likewise, the delivery cost is also high owing to the scale of operation as well as associated transaction costs. A case in point was the finding that the most significant reason for failure to use compounded feeds was the high cost. Veterinary costs were also very high because of the distance and rough terrain. Artificial Insemination service was used only in the Northern Province most probably due to the proximity to the boar studs. Most of those interviewed pointed out that the cost of AI services were beyond their reach.
- ii. *Buyer power*: Most pig producers (52%) said that the price of pigs offered by buyers and traders is a barrier to trade. Markets are characterised by limited information as is indicated by the finding that 65% farmers obtained information on pig markets from other farmers. However, there were some positive findings that indicate the producers' power to bargain for better prices. Among these are that farmers were strictly not 'price takers' as is common in most smallholder production systems. A majority (67%) pig farmers said that they determine the farm-gate price of their pigs. Likewise, 58% of pig farmers said that finding a buyer for their pigs was not a problem. These findings indicate that pig farmers are placed in

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<sup>60</sup>Porter, Michael E. "The Five Competitive Forces That Shape Strategy." Special Issue on HBS Centennial. *Harvard Business Review* 86, no. 1 (January 2008): 78–93.

a vantage position that can reduce buyer power in determining price. This is also an indicator of a potentially large market for Rwanda's pigs.

- iii. *Competitive rivalry*: Most of Rwanda's pigs are sold in live animal markets to traders from neighbouring DRC. This indicates that the Rwanda pig market offers mainly an undifferentiated product making it less competitive. This could however be driven by the ready market for pigs from the DRC. Competition could however arise in processed or value-added products segment which is still not well developed in Rwanda. The product range is diverse with processed products like special meat cuts, pork sausages and bacon among others. Most of these processed products are often consumed in niche markets that include high end hotels and domestic consumers. This would present a great opportunity for product diversification destined for the local market especially with the GOR's efforts to make the country an attractive tourist destination.
- iv. *Threat of substitution*: In a situation where close substitute products exist in a market, it is likely that consumers/ buyers will opt for alternatives in response to an increase in price. In this case, the close substitute product is other meats including beef, mutton and goat which is also exported to Rwanda. This however is not a foreseeable challenge since ruminants require more land to produce 1 kg of meat compared to pig. Land is a limiting resource for animal enterprises in Rwanda and therefore, the high preference for pig enterprises.
- v. *Threat of new entrants*: In the future, considerable competition for the lucrative DRC pig market could arise from East African Community partner state particularly Uganda and Kenya. However, the cost of pig production is relatively high in Kenya since most of the feedstuff are imported from neighbouring Uganda and Tanzania. Since Rwanda may not have obvious comparative advantage over Rwanda with respect to distance and availability of resources for pig production, then Rwanda could improve its position by creating durable barriers to entry, for example, patents, economies of scale, conformity to processing standards, industry support through financing and favourable government policies. This will allow industry players to have a competitive advantage through price leadership-Agricultural technical assistance programmes

From this analysis, two strategies that would contribute to increase competitive advantage for pig industry players were proposed, from which policies were suggested;

- i. Achieving cost leadership: The objective is to reduce the cost of production through adopting the use of technology, increasing economies of scale and reducing transaction costs thereby improving the efficiency of the value chain.
- ii. Promoting product differentiation: The objective is to facilitate delivery to the market of high-quality products (both process and product) for niche markets. This increases value added benefits to value chain players

Policy issues for consideration to drive the strategic options include;

1. Promoting the use of pig breeds that yield higher bio-economic values;
2. Promoting the use of Artificial insemination to increase access to good breeds of pig and gains of hybrid vigour;
3. Promoting establishment and membership to producer and marketing organisations to increase the benefits of bulking and volume purchasing;
4. Promoting access to credit to input suppliers and processors to promote private sector investment to strengthen the value chain as well as reduce associated transaction costs;
5. Promoting efficient knowledge management through use of technology;
6. Facilitating up-grading of processors by building their technical capacity to manufacture high value products through legislation for nationally accepted standards and designs for animal/pig slaughter houses;
7. Review of the taxation regime to reduce cost of imported inputs as well as promote export compensation for farmers and producers;
8. Improving infrastructure including internet access and roads to improve market access;
9. Promoting branding and international quality standards certification of Rwanda's pork products and processing plants;
10. Facilitating a registration traceability system with long term plan for introduction of web-based GIS embedded digital identification and traceability system;
11. Promoting 'decent work' issues in production and processing particularly eradicating 'worst forms of labour and child labour';
12. Mainstreaming gender and youth inclusion at all levels of the PVC and
13. Promoting environmental sustainability of enterprises in the pig value chain

## **5.4 Proposed strategies up-grading, extending and optimising technology in the pig value chain in Rwanda**

This section examines strategic points of the value chain that are likely to have a multiplier effect on national income as targets for up-grading, extending and optimising technology use.

### **5.4.1 AI up-scaling strategy: Linking provincial centres with district studs**

The major benefit of artificial insemination (AI) technology is accelerating genetic progress in pigs. The accelerated genetic progress results in enhancement of the desired genes in pig herds with increased growth rates, improved herd uniformity, quality of pork and reduced cost of feeding. Other benefits include overcoming the challenge of size difference during mating which often results in injury and anal ejaculations and minimising the spread of breeding diseases thereby improving the overall herd efficiency. Among the major disadvantages of AI in pigs is the fact that boar semen is very fragile and cannot be frozen, as is the case with bull semen. As such, boar semen can only be stored in chill conditions for a maximum of 7 days with fertility declining significantly thereafter.

Use of AI was only reported in the Northern Province where the technology was used to breed 34.5% of sow. This was associated with the close proximity to the semen production centres. This finding was also corroborated by key informants from RAB. The study therefore found the need to design of AI up-scaling strategy for pig farmers in the Republic of Rwanda so as to create demand for the service. The main challenge associated with low adoption of AI among pig farmers was the cost of insemination which was RWF 15,000 per pig which was unaffordable by most small-scale pig farmers. To achieve good conception rates, two or three inseminations in the heat period are necessary. This has a direct implication on the overall cost of AI because the inseminator has to make more than one visit. The rugged terrain and transport infrastructure also contribute to reduced accessibility to farms thereby increasing transport costs which is later passed on to the farmers. Further, many farmers did not know where to access AI services which reflects a gap in extension.

At the level of the smallholder pig enterprise, there were predominantly high numbers of indigenous breeds and their crosses in extensive and semi-intensive systems. The boar to sow ratio in pig herds was also high. Castration of male piglets was not commonly practiced yet majority of farmers obtained breeding sows from their own herds where record keeping was

poor. These findings explain the low demand of AI services despite the demonstrable benefits in herds that have adopted the technology.

The following are intervention strategies for up-scaling of AI for pig farmers in the Republic of Rwanda.

1. Reducing the physical distance between the pig enterprises and the source of genetic material;
2. Establish pig farmers clusters of to aid in AI planning, projecting demand for semen and reduce the cost of insemination;
3. Increase extension services, develop pig breeding program, and enhance AI efficiency through the increase of AI frequency and increase capacity-built service providers;
4. Promote private sector participation in AI service provision;
5. Overcome the challenges posed by infrastructure by developing affordable chilling and transport facilities; and
6. Introduce a pig recording system to assist in documenting progress.

To achieve consolidated gains that draw from these interventions, this study proposed linking of provincial centres with district studs as the over-arching up-scaling strategy. The functions of the provincial centre will include: to conduct research aimed at generating sire proofs, semen production and processing, distribution of boar semen to district studs and extension and training and accrediting inseminators. The functions of district studs will include; organising farmers into clusters, delivering AI services, maintaining district AI records and extension services.

Other players will include the GOR through relevant arms involved in registration of veterinary practitioners, improvement of existing infrastructure (roads, water, and electricity) and generally providing an enabling environment in terms of licencing and taxation of inputs. Private sector players will play an important role in supplying equipment and also commercialising AI services.

### **Model for semen production unit**

The projections for boar semen production centres are based on the LMP roadmap where piglet production is expected to grow to 266,561 annually. Assuming that 60% of piglets are bred from AI and that the number of inseminations per conception is 1.3, then projected annual semen requirement will be 207,918 doses. With each boar producing a minimum of 1100 doses annually (22 doses per week), a total of 190 boars are needed to meet this demand. This demand

can be met with 3 studs each hosting 60 – 70 boars. These centres could be located in Kisaro breeding centre, Rwamagana, Nyamagabe and Gisagara to ensure that they are easily accessible and the distance to the farmers is significantly reduced. This will increase efficiency of AI service provision and therefore conception rates resulting in improved demand for the service as well as increased productivity. Other benefits will include a significant decrease in the cost of boar semen and the eventual cost of AI services. The sustainability of investment in a boar semen production centre is evaluated on Table 25.

**Table 25 Model analysing income and expenditure for a boar stud (Unit with 70 boars)**

<b>Source of Revenue</b>	<b>Amount RWF</b>	<b>Fixed Costs</b>	<b>Amount (RWF)</b>
Sale of semen @3500/dose	269,500,000	Annual feeding cost	29,816,850
Sale of spent boars with a cull rate of 30% @100,000	2,100,000	Replacement boars	1,050,000
		Semen packaging and insemination accessories@68.8	2,695,000
		Disease control/vaccinations	7,000,000
		Laboratory expenses	2,695,000
<b>Total</b>	<b>271,600,000</b>		<b>43,256,850</b>
<b>Revenue – fixed costs</b>			<b>228,343,150</b>

*Key: RWF=Rwandan Francs, 1RWF = 0.0011 USD*

To evaluate the potential benefits of upgrading technology use on pig farms in Rwanda, a hypothetical case where boar services are replaced with AI services in a 6-sow farm was used and good records kept as well as improved feeding and reproduction management. In the model, values of bio-economic indicators from the field survey as well as values in secondary data were used. The plan put into consideration the different production operation options; farrow to finish, farrow to weaning and wean to finish as shown in Table 26. The assumptions made in the analysis were; that pigs are fed on commercially compounded feeds only; that the price of pig feed decreases by 10% due to increased competition between feed suppliers; price of AI will reduce by 30% due to increased availability with 1.4 inseminations per conception; 100% increase in the cost of services due to increased scale of operation; operational costs in a wean to finish and farrow to wean operation decrease by 30% and 60% respectively.

Results showed that up-grading technology in pig production resulted in improved bio-economic indicators, potentially increasing enterprise incomes by 200%. Results also indicated that wean to finish operations are likely less profitable at small scale level compared to farrow to finish and farrow to wean operations. Wean to finish operations have however been demonstrated to be very efficient when production is done in large scale due to compounding of costs and specialisation of labour. Despite higher gross margin, the gross profit per sow per year in farrow to wean operations is 3 times lower than that in farrow to finish operations.

**Table 26 Feasibility analysis evaluating adoption of technology for pig producers**

<b>Parameters</b>	<b>Bio-economic indicators</b>	<b>Percentage change</b>	<b>Amount (RWF)</b>
No of sows	6	52%	
Farrowing interval (days)	185	-8%	
No of litters from 6 sows	11.8	8.2%	
Average litter size	12	66.7%	
Piglets weaned per year (97%)	137	48.2%	
Average price of piglets	32942.8 (8 weeks)	10%	
Gross revenue for Farrow to Wean operation			4,513,163
Gross revenue from sold pigs in Farrow to finish operations			<b>11,636,667</b>
90% sold for slaughter	Maturity – 180 days		9,876,823
8% sold as breeders			1,632,228
Sale of cull sows	Sow herd life = 36months		127,616
Retained as replacement stock	1%		
Mortality	1%		
<hr/>			
Cost of production			
Cost of feeding sows	4% of body weight	120%	2,555,730
Cost of feeding grower-finishers	FCR = 3:1		4,796,370
Annual cost of labour		100%	283,218
Marketing costs		100%	108,408
Artificial insemination cost		-30%	176,400
Transport cost		100%	578,796
Veterinary costs		100%	74,170
Total annual cost farrow to finish operation			<b>8,573,092</b>
Gross profit per sow for farrow to finish operation		200%	<b>510,596</b>
Gross margin for farrow to finish operation			<b>35.7%</b>
Gross margin for Wean to finish operation			<b>9.3%</b>
Gross margin for farrow to wean			<b>43.3%</b>

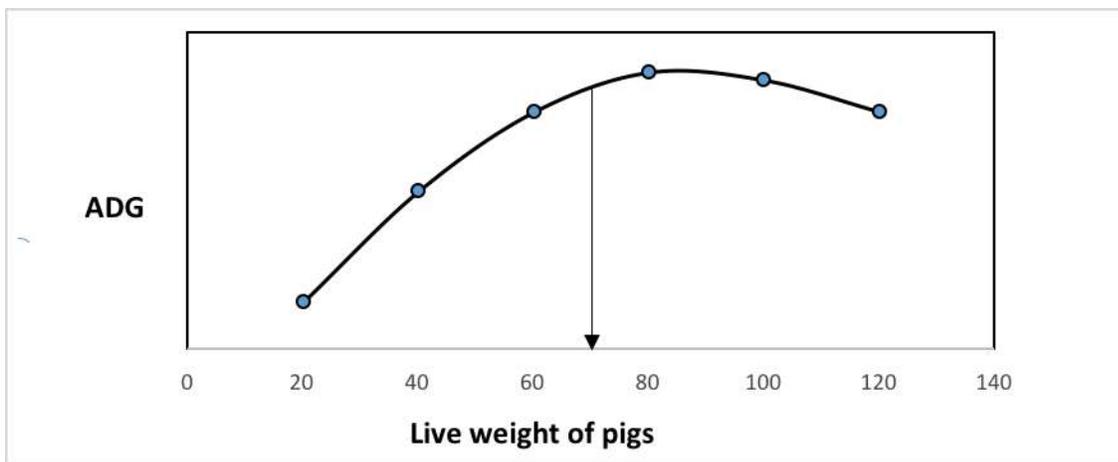
*Key: FCR = Feed conversion ratio, 1RWF = 0.0011 USD*

Up-scaling semen production would basically reduce the price of AI based on the current findings. With the GoR support, it is estimated that by 2024 the use of AI in pig production could

increase with a coverage of 60%. In 2017 pig population was estimated at 1.7 Million<sup>5</sup>; with a projected annual increase in pig population of 10%, the estimated pig population in 2024 will be approximately 3.3 Million, of which 60% will be sows. This increment would require that at least 2,782,768 semen doses are produced every year. To satisfy this demand, semen production centres will need to have in total, 1,146 boars by 2024. However, this will need sensitization and awareness campaigns to pig farmers on the merits of AI technology in pig breeding. The GoR will also need to support breeding centres in terms of technology acquisition but also subsidize on some inputs for semen production.

#### 5.4.2 Pig fattening / finishing centres; a strategy for increasing output

The recommendations of the LMP, 2017<sup>10</sup> under its recommended level of investment (RLI) proposal is to increase the total annual pork production to 67 MT by the year 2022. Establishment of pig fattening centres will be instrumental in helping to achieve this goal. The objective of pig fattening centres will be to increase the volume of finished pigs to the market for processing while delivering a quality product with the desired level of marbling and back fat thickness. To achieve this objective, investment in routine management, efficient pig breeds and feeding technology will be critical to ensure that pigs achieve slaughter weight (70 – 80kg) at 180 days as demonstrated in Figure 32. This is the point of inflexion for the average daily weight gain X age curve implying that the feed conversion efficiency gradually declines after this point.



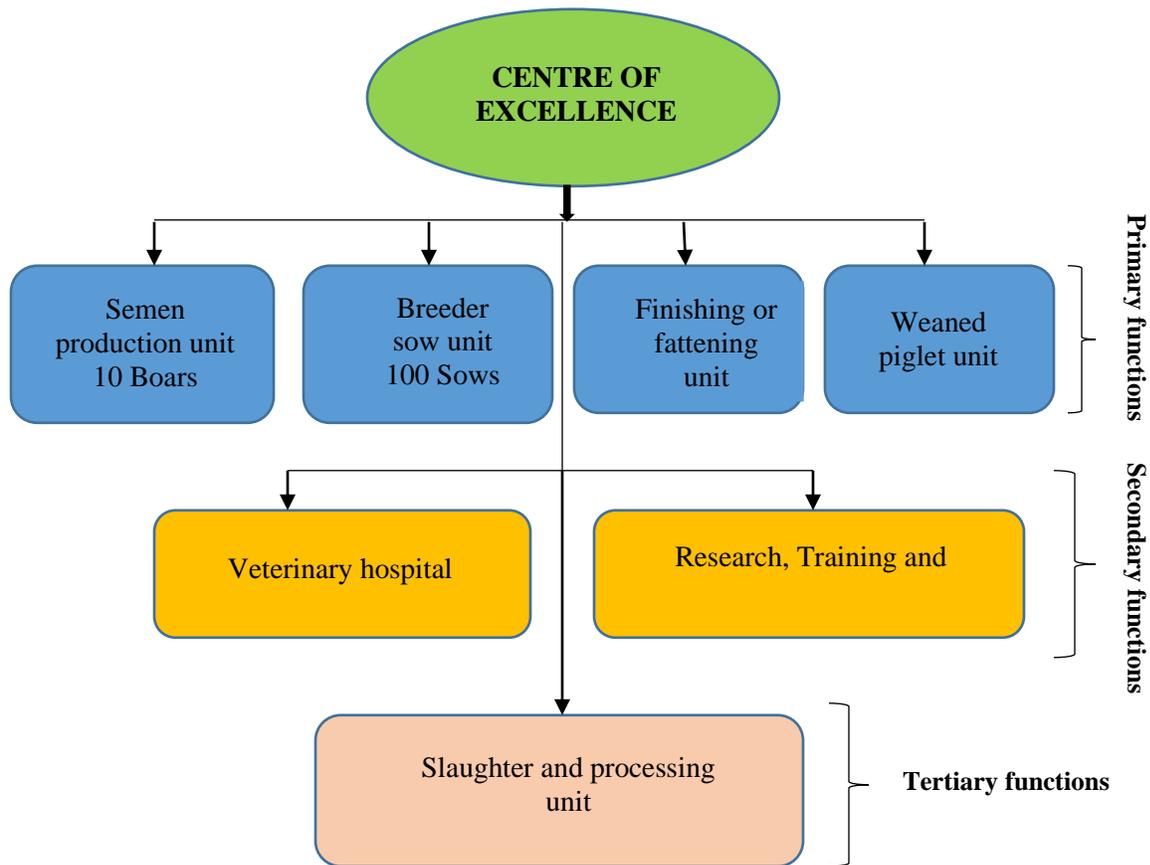
**Figure 32 A graph demonstrating weight gain efficiency in pigs**

Pig fattening centres will obtain weaned piglets from breeder farms and the centre of excellence which can be on a contractual basis. This will ensure a consistent supply of piglets throughout

the year. Collaboration with research laboratories for feed quality and the veterinary department for disease control will be essential for the success of the centres. Such centres would provide an ideal investment option for the private sector.

**5.4.3. Centre of excellence in breeding: A strategy for modelling up scaling of technology**

The objectives of establishment of a centre of excellence in pig breeding include building capacity in pig breeding and production management, promotion and up scaling of promising technologies, research, incubation and dissemination of technologies and building linkages with other value chain actors. The centre therefore will comprise of a semen production unit with a semen laboratory, a breeding sow unit, a fattening or finishing unit, an animal hospital, a training and research unit with a library and laboratory equipped with feed analysis equipment as shown in Figure 33. The centre can be expanded to vertically integrate slaughter and processing functions.



**Figure 33 Functions of proposed centre of excellence**

The primary functions of the centre of excellence will serve as a source of breeding pigs for dissemination to other producers, artificial insemination and weaned pigs for dissemination to other farmers and fattening centres. The centre with a sow population of 100 will have a capacity to produce 2200 weaned piglets annually. With a boar population of 10, the centre will have a capacity to produce 11,000 – 12,000 doses of semen annually (22 doses per boar per week). This semen will be disseminated to other farmers and breeding stations through provincial and district stud and also private veterinary practitioners offering AI services. Oestrus synchronisation protocols can be used to enhance the efficiency of AI services though good management and feeding practices could suffice.

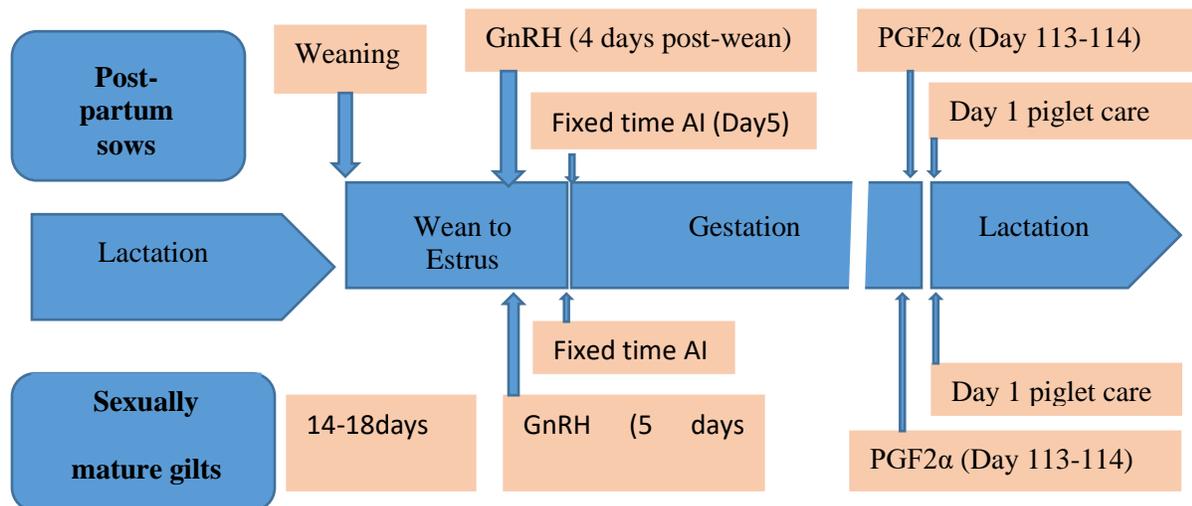
The research training and extension department will be essential in carrying out research on technologies that can be disseminated to farmers and offer extension services. This department will also offer hands-on training for pig producers, inseminators as well as offer research facilities for university students. This department could also host a pig feed processing unit which will be instrumental in nutrition research. The slaughter and processing unit will be a centre for incubation of pork processing technology as well as an innovation centre with a food quality assurance laboratory.

The GoR through MINAGRI and RAB will play regulatory and coordination roles where the centre shall be subject to all disease control measures and quality standards at all levels. The GoR's investment in the centre will be through provision of technical expertise and facilitation of outreach roles. Other partners' investments will be in form of infrastructure, animal stock and equipment. These could be achieved through the support of NIRDA.

#### **5.4.4 Reproduction management technology to optimize piglet production**

Reproduction management could improve the efficiency of breeding programmes such as those involved in multiplication of piglets such as centres of excellence. To optimise piglet production and reduce the sow replacement rate, it is necessary to deal with the high incidence of failure of post-partum sows to return to estrus and conceive. Likewise, fixed time insemination and farrowing could play a significant role in reducing peri-partum piglet mortality since supervision of farrowing can be organised easily. It also allows for batch farrowing making it easy to foster piglets where a dam cannot nurse piglets.

Commonly used technologies include the use of an oral progestin, Altrenogest® to synchronise the estrus cycle of gilts and gonadotropin releasing hormone (GnRH) analogues to synchronise ovulation thereby making it possible to do single fixed time artificial inseminations. This would significantly reduce the cost of AI and improve conception rates. Synchronised farrowing can also be achieved by administration of PGF2 $\alpha$  between days 113-114 of gestation. This is useful in reducing farrowing time and therefore reducing the incidence of uterine inertia, a common cause of stillbirths. It also increases the uniformity in size of the piglets and efficient use of facilities. A model illustrating management of the reproductive cycle is illustrated in Figure 34.



**Figure 34 A model illustrating management of the reproductive cycle**

*Key: GnRH=Gonadotropin releasing hormone; PGF2 $\alpha$ =Prostaglandin F2 $\alpha$*

#### **5.4.5 Piggery business hubs; a strategy to encourage participation of women and youth**

The objectives of the piggery business hubs will be to aggregate producers in cohorts with the common interest of providing training, increasing access to inputs, availing credit services and coordinating marketing. In Kenya, the SNV is implementing a programme “Enhancing Opportunities for Womens’ Enterprise (EOWE) Programme”. Following is an excerpt of the project document.

*“The programme aims to boost the start-up and development of women’s businesses in rural areas in Kenya through a combination of enterprise development, social transformation and policy advocacy interventions. The programme aims to increase the income of 22,000 female farmers and entrepreneurs by increasing business and farming*

*skills and access to inputs, productive assets, finance and markets in climate change context. On a societal level, the programme facilitates dialogue on social norms that influence unequal time spent by women on reproductive tasks, control over and use of income and resources, decision-making power and leadership within households and communities. The programme complements its enterprise development and social transformation interventions with policy influencing and advocacy activities to build the capacity of government and civil society actors to advocate for develop and implement gender-sensitive policies and plans in agriculture”<sup>61</sup>.*

The piggery business hub approach will be an innovative means to increasing women and youth participation in pig production as well as establishment of sustainable rural pig enterprises in Rwanda.

#### **5.4.6 Strategies for up-scaling market linkages in the piggery value chain in Rwanda**

In Rwanda, pig farming contributes significantly to improving the standard of living for smallholder farmers. However, market for pig meat products is largely limited and pigs are sold as live animal or are slaughtered and consumed with limited value addition. The level of productivity is still very low due to poor access to market information and linkages between various stakeholders especially those that provide essential services to pig producers. This creates inefficiency that opens door for poor quality products. Many participants in the pig value chain face a number of constraints such as high transport cost, lack of credit from financial institutions, high price of inputs, limited access to market information and lack of capital. These are characteristics of a thin market which is often characterised by inefficiency.

#### **Proposals for up-scaling market linkages include;**

- i. The Government of Rwanda could engage other partners such as NGOs and private enterprise in establishing Public-Private-Partnerships (PPP).
- ii. Promoting pig products marketing through cooperatives as a mean of linking smallholder pig farmers to markets as a key pillar of Rwanda’s rural development strategy.

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<sup>61</sup> SNV Enhancing Opportunities for Womens’ Enterprise Programme Document. <https://snv.org/project/enhancing-opportunities-womens-enterprises-ewoe>

- iii. Establishment/ strengthening of Farmer-Field-Schools (FFS) where smallholder farmers can engage with established pig farmers who operate at a higher level in the value chain. These FFS also act as contact points with service providers
- iv. Hosting trade fares for pig industry stakeholders including producers, marketers, processors input suppliers, technical and financial service providers, cooperatives, researchers and exporters

#### **5.4.7 Proposed interventions for upgrading and optimising technology at slaughter and processing**

Since there are only two licensed pork slaughterhouses in Rwanda, it is critical to have more slaughterhouses and upgrade the existing slaughterhouses to take care of the growing population of pigs. For new slaughterhouses, the government and or key partners need to support construction of modern slaughterhouses. The existing and licensed slaughterhouses need to be upgraded by providing technical assistance, capacity building, machinery provision, adequate equipment for quality checks and traceability. Such equipment would include:

- Stunning equipment (electric)
- Hoist (manual or electric)
- Scalding vat and dehairing machine,
- Scrapping/ gambrelling table (stainless steel)
- Electric splitting saw and breastbone saw.
- Use of bio digesters would be an innovative approach in managing waste.

Majority of small and medium scale processors are unable to meet acceptable quality and packaging standards and therefore lose out on key markets including local and export market. These existing gaps present business opportunities in processing and marketing of pork meat and pork products.

#### **Slaughterhouse requirements**

There are a number of considerations involved in decisions to establish a slaughterhouse and include:

1. Policy decisions: these are made depending on the size, location, capacity and product range
2. Engineering aspects involving the layout plan

3. Cost of investment
4. Infrastructure which depends on the maximum daily kill, waste disposal and by-product processing

### Site selection

The ideal site should

- Be in the outskirts of urban areas
- Allow for easy drainage
- Have portable water
- Have reliable power supply
- Away from airports since waste attracts birds
- Be free from pollution from other plants such as chemical plants
- Should be a separate entity, separate from other buildings

### Abattoir size

This depends on the number of animals to be slaughtered daily and the range of operations. This will also vary with the locality of the slaughterhouse with respect to pig populations as well as the intended range of product processing. Large abattoirs could also be integrated to incorporate a rendering plant. The requirements for land will also vary as shown in Table 27.

**Table 27 Slaughter capacity and land requirements for slaughterhouses**

Abattoir size	Daily capacity (livestock units/day)	Land requirement (acres)
Small	Less than 100	1 - 2
Medium	100 - 200	2 - 4
Large	More than 200	4 - 6

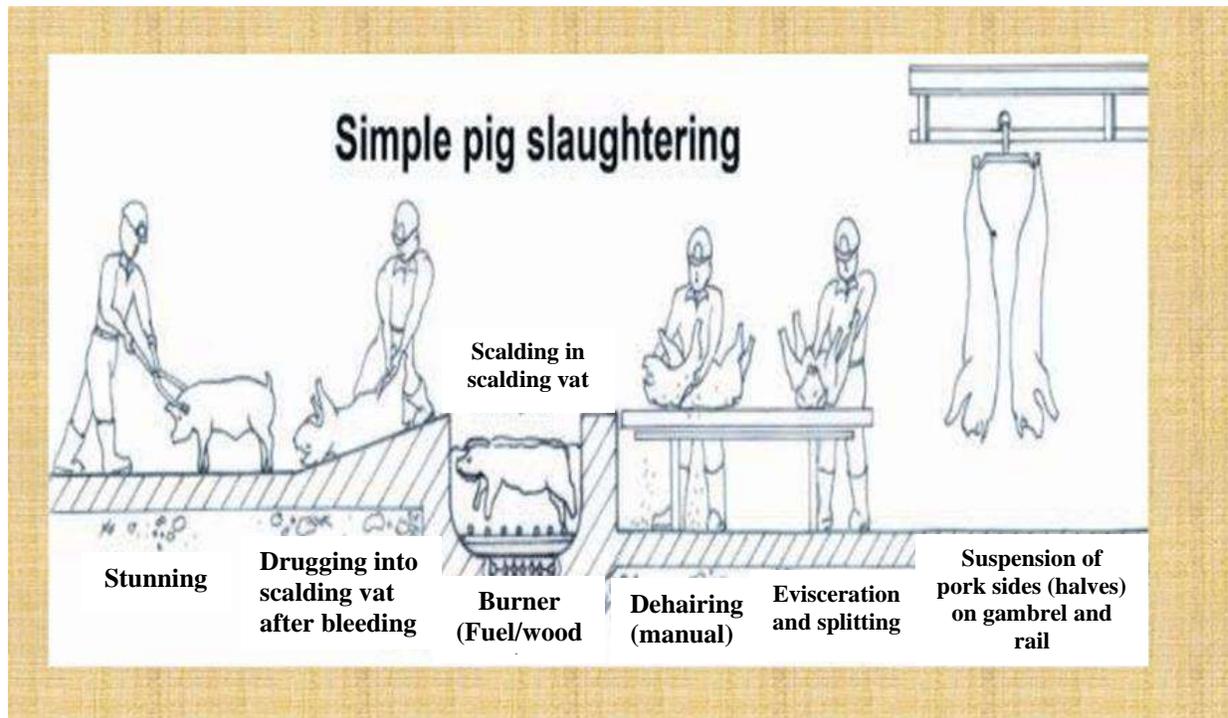
*Source: Kumar, (2020)<sup>62</sup>*

Considerations for pig abattoir design include:

- Separate clean and un-clean areas
- Floor gradient of 2cm/metre
- Non-slippery floor, wide doors (1.5m)

<sup>62</sup> Kumar P. (2020) Infrastructural requirements of modern slaughterhouse. <https://www.slideshare.net/pavankumar528316/inf>

- Water requirements: Hot water for cleaning (82°C), sufficient volume 10,000 lit/tonne of dressed carcass weight
- Scalding of stunned pigs should be at 61 – 64°C for 6 minutes
- Singeing using a gas flame can be done as an alternative to manual scraping with a knife to remove excess hair.



**Figure 35 Model of a small slaughterhouse showing the slaughter process**

*Source: Kumar, (2020)<sup>1</sup>.*

#### **5.4.8 Proposed interventions to improve technology at consumption**

The overall objective of technological interventions at consumption will be to increase access to a variety of wholesome, presentable and competitive products to the consumer and to increase sales volumes for vendors. Technological intervention should therefore focus on;

- Increasing the product range to diversify consumer choice
- Creating product knowledge through advertising campaigns
- Quality assurance through formalising retail pork trade, licencing and enforcement and hygiene
- Meat storage technology such as freezers and cold-rooms

- Innovative packaging and product presentation
- Product branding
- Market segmentation

Most of these interventions are capital intensive and therefore, government support to the private sector through NIRDA's open calls would play a significant role in financing investment and capacity building.

## **5.5 Investment potential and opportunities in the piggery value chain in Rwanda**

From review of literature and quantitative and qualitative studies carried out, it was evident that the piggery value chain is gaining importance as a poverty eradication strategy and a potential investment pathway with meaningful economic gains for the country. To improve sustainability of the value chain it is necessary strengthen it through investments at points that can be leveraged upon to improve efficiency and create jobs. There are 3 investment pathways that can be employed;

### **5.5.1 Government investment**

These would include investments in regulatory bodies such as in technology for quality evaluation of meat and processed meat products, animal feeds and feed additives and traceability systems. These investments act as a catalyst to investment in a sector since they provide a system of quality assurance hence opening up markets including export markets. As an extension to creating an enabling environment, it would be critical for the GoR to invest in de-risking mechanisms by ensuring a stable macro-economic environment and a favourable tax regime for imported technology.

### **5.5.2 Private enterprise investment**

With the projected increase in pig population and up-scaling of technology, it is anticipated that the demand for inputs and services will increase in an attempt to increase production efficiency. Private enterprise investment in feed processing, import of raw materials such as vitamin and mineral premixes and amino acids for the feed industry, distribution of drugs and supplements and veterinary services and artificial insemination will be a necessity rather than an option.

Investments in high quality export slaughterhouses, refrigerated meat carriers and in the retail and wholesale segments will provide opportunities for many actors. The pork processing business is relatively unexploited and provides a lucrative opportunity for private investment.

Private enterprise can also invest in breeder studs, sow breeding farms and pig finishing enterprises.

### **5.5.3 Public-Private Partnerships (PPP)**

For reasons of compliance with international standards such as the OIE standards for disease control, governments may not transfer such functions completely to the private sector despite the fact that it creates vast opportunities for private sector investment. Public goods constitute those services that can only be offered by government and include regulatory function, disease surveillance, control and identification and traceability systems through the Director of Veterinary Services as the regulator. On the other hand, private goods can be offered by the private sector such as clinical services, vaccination, AI, drug, vaccines and other input supply and extension services. PPPs provide a win-win solution for both the public and private sector and by extension, the consumer of these services.

Investments that require large capital outlays such as establishment of a large volume export slaughterhouse or expensive equipment for meat processing, PPPs could play a significant where a private actor secures credit using a government guarantee. Similarly, government may partner with an off-shore private investor to establish a plant.

## **5.6 Feasibility model for technology in the piggery value chain**

This section models a value chain structure and evaluates the feasibility by analysing possible outcomes of implementation of the value chain model

### **5.6.1 Proposed piggery value chain feasibility**

#### ***Overview of pig markets***

An analysis of Food and Agriculture Organisation of the United Nations statistics (FAOSTAT) indicates that the domestic demand for meat is increasing by more than 2000 tonnes annually. The growth in conversion rate for live pigs to pork between 2011 and 2017 stood at 115%

against an increase in pig population of 107%<sup>63</sup> in the same period. This indicates a significant increase in pork production at a higher rate than the pig population growth implying that there is a need to increase pig production to meet the current demand for pork. Live pig markets are scattered in the Northern, Western and Southern provinces with 14, 29 and 21 markets respectively<sup>64</sup>.

The demand in the export pork market to the Democratic Republic of Congo is largely unmet as owing to the large size of the market that is not easily accessible due to long distance and poor roads<sup>8</sup>. However, the challenge of meat spoilage due to long distance can be overcome by investing in refrigerated tracks.

### ***Market prospects and pork prices***

In 2016, 311,040 pigs are sold annually in live pig markets in Rwanda to livestock traders from DRC<sup>40</sup>. However, these traders offer higher prices for live pigs compared to the price offered by abattoirs in Rwanda. Live pigs are therefore sold to the highest bidder denying Rwanda abattoirs the opportunity to do value addition and benefit from higher prices. Though the installed capacity for meat processing in Rwanda is under-utilised, there is limited technical capacity thereby limiting potential benefits from trade in value added products. It is projected that once slaughterhouses in Rwanda are up-graded to export status, Rwanda could take advantage of DRC's processed pork product market which is worth USD 37,293,852<sup>40</sup>.

### ***Production prospects***

Results in this study show that the number of finisher pigs sold per enterprise was 1.8. The inherent characteristics of pig enterprises including low requirement for land and labour, high turnover and faster return on investment favour pig farming compared to other ruminant livestock. Most smallholders in Rwanda are however constrained by land and therefore have a preference for pig farming. The increase in demand for pork and pork products against a static land resource calls for investment in technology to increase production efficiency while putting into consideration the environmental impact of increased production. This study proposed a pig value chain up-grading protocol as shown in Table 28 and then presented possible scenarios its economic impact.

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<sup>63</sup> Strategic and investment plan to strengthen meat industry in Rwanda, 2017. [https://www.minagri.gov.rw/fileadmin/user\\_upload/documents/STRAT.PLC/Final\\_report\\_Rwanda\\_Meat\\_industry\\_final.pdf](https://www.minagri.gov.rw/fileadmin/user_upload/documents/STRAT.PLC/Final_report_Rwanda_Meat_industry_final.pdf)

<sup>64</sup> MINICOM, 2016. Rwanda Strategy for Rwanda Meat Exports to DRC.

**Table 28 Proposed pig value chain plan for upgrading the pig value chain**

<b>Particulars</b>	<b>Current practice</b>	<b>Proposed model</b>
<b>Production</b>		
Production system	Semi-intensive and extensive	Intensive
Mating	Predominantly natural	<ul style="list-style-type: none"> <li>- Raise AI coverage to 80%</li> <li>- Increase boar centres</li> <li>- Link boar centres with district studs</li> </ul>
Breed	Mixed	Exotic breeds (Landrace, large white, pie-train, duroc jersey)
Information management	Manual	Digital
Feeds and feeding	Multiple resources	Feeds formulated according to nutritional need
Disease control and health management	Reactive approach	Preventive approach
<b>Processing and processing</b>		
Slaughter and processing	Slaughter slabs	<ul style="list-style-type: none"> <li>- Certified export slaughter houses</li> <li>- Blast chilling in addition to standard chilling</li> <li>- Value added products e.g sausage, bacon</li> </ul>
<b>Marketing and distribution</b>		
Live pig marketing	Farm-gate and live animal markets	<ul style="list-style-type: none"> <li>- Up-grade to cooperatives or on-line marketing bureaus to supply on demand</li> </ul>
Logistics	-Bicycles, motorcycles, pick-up trucks	<ul style="list-style-type: none"> <li>- Standard purpose built vehicles for live animal transport</li> <li>- Refrigerated vehicles</li> <li>- Licenced containers</li> </ul>
Retail and wholesale	-open butcheries -Eateries/ bar	

A piggery value chain model that put into consideration the proposed interventions was visualised as shown in Figure 36 that summarised the flow of goods and services, from production to consumption. Estimates were then done to evaluate the projected impact of upgrading, extending and up-scaling technology use on the economy.

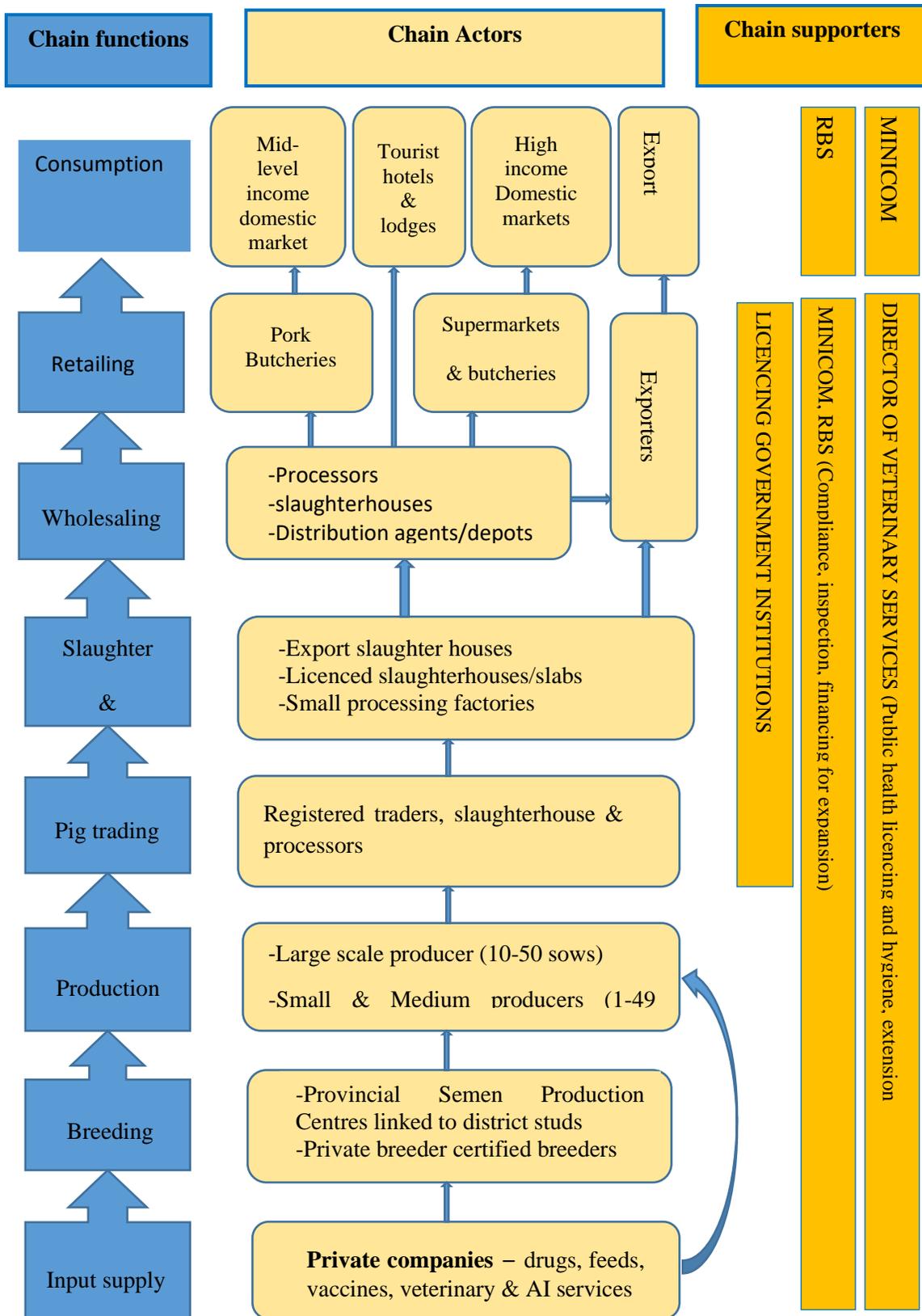


Figure 36 Proposed piggery value chain model

### 5.6.2 Technical and economic evaluation of the proposed value chain model

Reference was made to the study data, the resulting feasibility model and secondary data from GoR statistics regarding meat sales. Out of 517,140 pig farmers in Rwanda, 14% are in semi-intensive systems and would be targeted for up-grading; 72,400 farmers. In the evaluation, it was assumed that in the first year, at least 10% of enterprises in semi-intensive systems are up-graded to intensive systems based on the objectives of the Rwanda Livestock Master Plan of 2017.

Results in Table 29 show that the economic impact of upgrading, extending and up-scaling technology in the pig value chain in 10% of pig farmers in semi-intensive systems in Rwanda can generate USD 74.2 million in annual revenue. In subsequent years, these values are likely to increase with an increase in technical capacity and efficiency. These findings depict a development approach that will contribute significantly to poverty eradication and inclusive growth for women and youth.

**Table 29 Projected economic impact of upgrading, extending and up-scaling technology in the pig value chain**

Source of income	Reference value	Percentage change	Annual value of the change (USD)
No of enterprises targeted	7240		
Live animal sale	Annual live pig sales	48.2%	14,328,904
Processed pork products	DRC's processed pork export market	10%	3,729,385
Pre-formulated feeds (kg)	34680kg annually	13 times	54,355,319
Employment income (On-farm)	Annual enterprise labour cost	100%	1,127,774
Employment income (services)	-Veterinary costs -AI costs (50% of total)		702,425
<b>Total</b>			<b>74,243,807</b>

*Key: DRC = Democratic Republic of Congo; IRWF = 0.0011 USD*

### 5.6.3 Forecast on the impact of up-grading, extending and optimising technology use on employment and job creation

Among the immediate gains expected from efforts in upgrading, extending and optimising technology use in the PVC is creation of jobs opportunities particularly at the producer and

processing levels as shown on Table 26. It is anticipated that at production, the number of jobs will increase by 100%. Further, the quality of the jobs will be higher than in the current precarious state. This is because, with increased and more stable income to producers, employment on farms will be consistent and more secure. There is also a likelihood of creation of jobs that are more permanent rather than seasonal or contractual or task-based. As a result, workers will afford enhanced social services such as healthcare and social security.

According to the LMP 2017<sup>10</sup>, the GoR intends to upgrade existing slaughterhouses to export facilities and pork product factories. This will create jobs for various cadre of people including; slaughter men, meat inspectors, cleaners, electricians, plant operators and drivers. A plant with a daily killing and processing capacity of 500 pigs could directly employ 300 workers at the different levels representing significant potential for employment creation.

The proposed piglet multiplication centres, pig fattening centres and breeding stations will also be significant in directly creating employment for farm workers and animal production specialists since these are high value investments. These will by extension create more jobs in private veterinary service provision as well as for AI providers.

#### **5.6.4 Potential for employment creation in feed processing**

Feed processing factories require different cadre of workers including animal nutritionists, quality control supervisors, plant operators, packers, loaders and sales people. A feed factory with a daily production capacity of 30 MT can employ 50 - 80 people in the different areas of production depending on the level of automation. If the recommendation in LMP 2017 to establish 5 feed manufacturing factories is effected, this would create direct employment for up to 400 people.

### **5.7 Proposals for strengthening of the enabling environment**

The success of future investments in the piggery value chain will to a large extent be dependent on an enhanced enabling environment. Various technical and institutional issues that could slow the upgrading of the piggery value chain were identified and proposed interventions are outlined.

#### **5.7.1 Veterinary service provision**

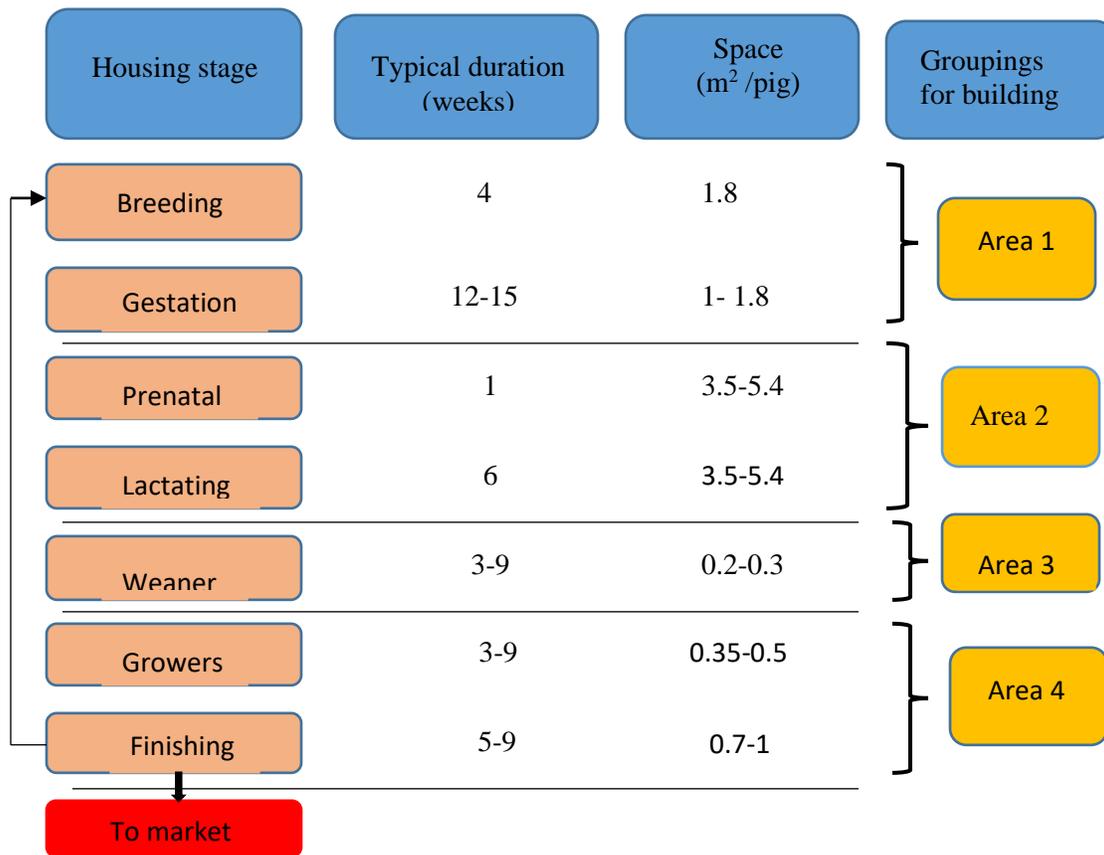
With the aim of minimising losses associated with disease, this study identified strategies that would inform disease control and management policy in Rwanda;

- Proper coordination of monitoring, reporting and management of infectious disease outbreaks. Since veterinary services are offered by GoR veterinarians, private veterinarians and CAHWs, all returns should be made to the District Veterinary office.
- Establishment of a national disease control programme for all livestock with particular consideration of highly infectious and zoonotic diseases like African swine fever (ASF) and Swine cysticercosis. Key measures would include vaccinations, imposition of quarantine and transport inspection and certification.
- Encourage continuous professional development among livestock healthcare workers to build their capacity in disease identification and management

### **5.7.2 Livestock production advisory services**

An advisory service will be very instrumental in educating pig producer on the various aspects of piggery management including housing, feeds and feeding, recording, management practices and production planning. This could be effected through development of a training manual that puts into perspective individual pig requirements and the production environment of the Rwandan pig farmer. The following could be included in the training manual:

- iii. Pig production cycle: This should help the farmer to establish how many pigs/sows he/she needs for his enterprise and his expectations for the number of piglets per sow cycle.
- iv. Pig housing: (See Figure 37 for space requirements). This should have specifications for the space requirements for each class of pigs including dry and suckling sows, boars and growers (barrows and gilts). It should also have structures like feeding and watering troughs or nipples and heating facilities for piglets. This should also include an appropriate feed store to ensure feeds are well stored to avoid spoilage. A loading ramp should also be included to minimise handling stress on pigs.



**Figure 37 Housing requirements of pigs**

- v. Pig feed requirements (for example, energy, amino acids, dietary fibre) and feed resources that provide these requirements. Where commercial feeds are inaccessible or where there are easily available alternative feedstuffs, advice on how to use should be provided. For producers who would want to integrate vertically by producing feeds, guidelines can be provided.
- vi. Recording: The manual can have a template for pig recording. This can further be supported by a digital application that can be uploaded on mobile phones. Such records should include details on insemination, farrowing, health and production.
- vii. General management practices such as deworming, external parasite control, iron injections for piglets, teeth clipping and animal movement and handling procedures
- viii. Pig breeds and individual breed characteristics

### **5.7.3 Knowledge management and transfer**

Among the methods that have successfully been used in technology and knowledge transfer in agriculture are;

i. Farmer to farmer approach

Farmers show great interest in their fellow farmers activities and therefore when one farmer shares his progressive views with others, technology sharing is effected easily. In this case, farmers who have successfully applied a particular technology serve as the trainers for other farmers. This method has been successful because learners learn through demonstration of the technology

ii. Farmer Field Schools.

The setup of farmer field schools (FFS) is typically experimental where participants learn by observation of outcomes over a period of time. In a typical FFS, a group of 20-25 farmers meets once a week in a local field setting and under the guidance of a trained facilitator. Two or more experimental setup are put in place for comparison with a recommended technology and differences in performance are observed. At the end of the weekly meeting participants present their findings in a plenary session, followed by discussion and planning for the coming weeks.

iii. Functional literacy programmes

This approach is ideal in the rural environment since it is flexible and therefore inclusive especially for women who are often tied up with household chores. These programmes consist of common interest groups that meet at convenient times and decide on their training needs. For such programmes to be successful, the following are key;

-a supervision and support system for learners

-tutor training to ensure consistency

-collection and distribution of relevant training material which should be adapted to the specific environment and

-curriculum development in a language that the target group will understand.

These programmes could be used as platforms for improving farmers' capacity to invest and addressing risk through provision of information on access to credit services and promoting livestock insurance. The programmes will also be a platform to showcase the benefits of

intensive systems vis-à-vis extensive systems with the aim of up-grading enterprises under extensive systems to intensive systems

#### **5.7.4 Enforcement of quarantine measures**

Restriction of animal movement is a critical component of disease control and containment and is the responsibility of the Director of Veterinary Services. In most cases, pig movement is usually done through non-conventional routes to avoid such measures. For such measures to succeed, collaboration between veterinary officers and law and order enforcement organs is inevitable. Communication of such measures is also key to ensure that participants in the value chain are compliant.

#### **5.7.5 Enforcement of fair-trade practices**

The Rwanda Consumer and Competition Policy has been in place with the aim of stemming anti-competition behaviour. Among its objectives is to ensure that small and medium-sized enterprises have an equitable opportunity to participate in the economy. To achieve this for participants in the PVC, marketing standards need to be formulated and enforced through this law to limit exploitation of producers by intermediaries and other buyers

#### **5.7.6 Formalisation of live pig markets**

This is key to ensuring enforcement of contracts. As a result, it plays a significant role in reducing transaction costs with net benefits to vendors.

### **5.8 Mainstreaming of cross-cutting issues in policy**

Among the main cross-cutting issues that require attention in the policy making process are:

i. Gender inclusivity:

The following are proposals for consideration in policy making as well as advocacy with regards to gender inclusivity:

- Improving access to microfinance to women through creation of a Women development fund that can be a source of credit;
- Promoting parallel technologies that benefit women such as biogas
- Empowerment through trainings in local women groups,
- Design funding proposals that favour access by women,
- Set requirements for training such that women are not left out

ii. Youth and employment in agri-food chains

The following are proposals for consideration in policy making as well as advocacy with regards to youth and employment:

- Institutionalising innovation platforms
- Promoting the use of IT to develop solutions to challenges in the value chain
- Advocacy for inclusion of youth in employment policy
- Youth involvement in technical training programmes such as AI, feed processing and meat technology

iii. Sustainable environmental management and climate change

The main issues under environment and climate change include;

- Requirement for an environmental audit in all investments. Though this requirement is already anchored in law, there is need to build capacity in inspection and enforcement,
- Promotion of climate smart technologies that reduce emission of greenhouse gases (GHG)

iv. Disaster management

This is one of the areas identified in PSTA 4<sup>3</sup> under cross-cutting issues in policy development. This study was carried out during the COVID 19 pandemic period which has elicited operational problems in agriculture due to imposition of travel restrictions, both local and international. This has had significant effects on access to inputs, services and market for most farmers. It has also had a negative impact on related enterprises as a result of mandatory closures thereby depressing consumption. The consumption of pork has also experienced a decline due to closure of bars and restaurants with resultant high prices of pork due to shortage and job losses. This presents a situation that should be used as a case study for developing policies that may in the future help the GoR develop disaster management and mitigation measures as well as assist actors to build resilience and coping mechanisms.

v. Decent work for all.

Creation of decent working opportunities is one of the indicators of the United Nations Sustainable Development Goal No. 8. The pillars of decent work include;

- Employment creation and enterprise development with equal opportunities for all,
- Standards and rights for all that promote elimination of child labour and worst form of labour,

- Social protection for workers and
- Social dialogue

## **5.9 Proposed investment interventions by the National Industrial Research and Development Authority (NIRDA)**

### **5.9.1 Justification for investment**

NIRDA is a service-based institution whose objective is to improve competitiveness of existing industries through identifying new subsectors and value chains where investment by the private sector would likely lead to export growth. NIRDA’s support to enterprises consists of logistical support in acquisition and adaptation of specific technologies, acquisition and provision of technical support and expertise and training of staff to maximise productivity<sup>65</sup>. NIRDA selects priority value chains with best prospects for achieving its objectives through evaluating their potential for upgrading, extending and optimising.

This study has shown that there is vast potential for upgrading, extending and optimising at the various nodes of the piggery value chain with potential to increase operational efficiency and increasing production both for the local export and for export. The study has shown that there is need to upgrade on existing technology, extend current technologies in use such as AI and to improve the efficiency of production and processing units so as to optimise output using available resources.

### **5.9.2 Value chain functions where NIRDA can support**

These can be viewed from the lens of NIRDA’s approach, that is, acquisition of technology, provision of technical support and expertise and training.

#### ***Production node***

- Pig housing: construction using locally available materials, construction plans, waste disposal plan
- Animal registration and traceability systems software
- On-farm feed formulation: provision of technical information and support for acquisition of feed technology (Feed formulation software, rations and mixing and weighing equipment)

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<sup>65</sup> National Industrial Research and Development Authority Open Call Concept. <https://www.nirda.gov.rw/open-calls/>

- Automation of feed processing technology
- Investment in AI service; equipment and training for animal health practitioners

***Marketing node***

- Acquisition of appropriate vehicles for pigs and refrigerated carriers for pork
- Technical support for marketing initiatives for pork products

***Processing node***

- Acquisition of modern slaughterhouses
- Acquisition of modern stunning technology during slaughter e.g. electric or CO<sub>2</sub> stunning
- Acquisition of meat chilling facilities
- Acquisition of electric meat cutters
- Acquisition of technology and training in processed meat products such as sausage, bacon, meat cuts and any other innovations
- Acquisition of appropriate packaging technology

***Consumption node***

- Acquisition of value addition equipment
- Training on meat handling and meat hygiene
- Acquisition of food-grade meat display compartments

**5.9.3 Business support services that NIRDA can provide**

Infrastructural support to enterprises should go together with capacity building in soft skills to ensure a holistic approach to business support. The following are areas where NIRDA can provide training to so as to optimise management efficiency;

- Development of business/ investment plan
- Basic business accounting
- Business finance
- Marketing
- Business/ livestock insurance
- Quality standards and quality certification

## CHAPTER SIX

### SUMMARY FINDINGS OF THE TECHNOLOGY AUDIT OF THE PIGGERY VALUE CHAIN IN RWANDA

#### 6.0 Introduction

This chapter provides a summary of findings on technology gaps in the piggery value chain. It then provides a summary of strategic objectives to increase competitiveness of the PVC through upgrading, extending optimizing technology, proposed technological interventions and impacts of outcomes.

#### 6.1 Summary findings on technology gaps

Table 30 gives a summary of technology gaps that were identified in this technology audit.

**Table 30 Technology gaps in the piggery value chain in Rwanda**

Technology use in:	Current practice/ gap	Technology needs
<b>1. Production</b>		
Production systems	-66% Intensive systems -14% Semi-intensive systems -20% Extensive systems	-Upgrade housing to improve animal comfort and reduce infectious diseases -Optimise stocking ratio (Boar: sow) to reduce production costs
Genetic improvement	-78.6% of pigs kept are Exotic breeds -11.7 % of pigs kept are Indigenous -9.7% of pigs kept are Indigenous crosses	-Upgrade to breeds with better bio-economic indicators
	-64% of replacement boars from own farm -58.7% of replacement sows from own farms	-Optimise productivity through reducing in-breeding
	-100% Natural mating in Eastern, Western and Southern Provinces -34.5% Artificial insemination –only in the Northern province	-Optimise production cost through extending AI technology
Feed quality	-75.8% of pig farmers access hindered by high cost of commercially compounded feeds -52.2% of pig farmers hindered by poor quality of feeds	-Improve feed quality to optimise pig productivity through reduction of feeding costs

Traceability systems	-Traditional methods used to keep records e.g. used of names based on colour, appearance	-Upgrading traceability systems to improve gains from quality assurance
Pig marketing	-Traditional: price determined by buyer	-Optimise farmers' incomes through structured pricing systems based on weight and carcass quality -Upgrade market systems to provide information to producers
<b>2. Transport, slaughter and processing</b>		
Animal comfort prior to slaughter	-58% transport on foot -Transport by Vehicles limited	-Optimise meat quality by upgrading transport using of licenced carrier vehicles
Slaughter and post-harvest meat quality	-Only 2 licenced pig slaughterhouses -70% of pork in butcheries from home slaughter with no inspection -100% of slaughter in slabs performed on floor, traditional stunning by heavy blow on head -100% of slaughter slabs –use machetes to portion pork and cut bones -No chilling or freezing facilities	-Optimise on incomes through reducing loss of storage properties of meat, post-harvest losses, quality meat cuts and improved consumer perception -Enforcement to deter home slaughter for commercial purposes
Processing	-Only in one licenced slaughter house producing processed pork products -Exports consist mainly of live pigs, limited export of processed meat	-Capacity building on technology to promote new product development -Innovative technology in marketing so as to optimise existing processing capacity
Quality assurance	-Only 2 slaughterhouses with HACPP certification	-Need to upgrade one slaughter facility in each province
<b>3. Consumption</b>		
Meat hygiene	-16.9% of consumers dislike pork due to poor quality -Low processed product knowledge	-Technology that helps improve consumer perception on quality
Value addition	-No special meat cuts in butcheries -No minced meats	-Marketing platforms for processed pork products -Innovative packaging and presentation -Branding -Market segmentation e.g. low fat and high fat sausages

## **6.2 Potential for upgrading, extending and optimising in the piggery value chain**

This section identifies key areas where investing in technology has potential for production of higher value-added products and job creation in the PVC.

### **6.2.1 Potential for upgrading**

Among the areas that were identified for potential upgrading to a higher value-added component of the PVC were:

- Upgrading extensive systems to commercial intensive systems
- Breed improvement to improve bio-economic values
- Upgrade animal registration systems to enhance traceability systems
- Upgrade animal transport to improve product quality and reduce pre-harvest losses
- Upgrading slaughter slabs and slaughterhouses to comply with established quality control standards
- Expanding capacity of slaughterhouses to process value added products

### **6.2.2 Potential for Extending**

Potential area of extending actions that broaden existing the PVC to increase its full potential job creation and value-added impact

- Expanding access to artificial insemination
- Expand feed production to cater for rising number of pigs in commercial systems
- Capacity building at production and processing

### **6.2.3 Potential for optimising to achieve efficiency**

Potential actions to improve operations in the PVC and achieve greater value added included:

- Automation of intensive systems such as feeding, watering and data management
- Increasing piglet production in specialised farms for fattening
- Increasing market efficiency at all levels
- Investing in research and development of value-added products
- Incentivising sale of live pigs to slaughterhouses rather than to live pig export markets
- Reduction of post-harvest losses by investing in cold chain technologies
- Increasing sales volumes (domestic consumption) through improving consumer perception

## **6.3 Strategic objectives, proposed technological interventions**

Two broad strategic objectives to increase competitiveness of the PVC were identified; 1). Achieving cost leadership through adopting the use of technology, increasing economies of scale

and reducing transaction costs and 2). Promoting product differentiation with the objective of facilitating delivery to the market of high-quality products. Proposed technological interventions and estimated impact were as presented in Tables 31 and 32.

**Table 31 Proposed technological interventions that achieve cost leadership**

<b>Proposed technological intervention</b>	<b>Outcome</b>	<b>Projected impact</b>
<b>Production</b>		
Upgrade 10% of semi-intensive systems to intensive	-Increased output -Increased efficiency	-7240 smallholder producer units upgraded
Upgrade existing breeds of pigs by increasing the percentage of more efficient breeds by 30%	-Increase mean litter size to 12 -Reduce pre-weaning mortality -Increase maturing rate	-52% increase in number of breeding sows -Decrease farrowing interval by 8%
<b>Specialisation:</b> establish pig breeding and fattening units	-Increase output -Increased production efficiency	-Increase average litter size by 66.7% -Increase number of weaned piglets per sow per year by 48.2%
<b>Specialisation:</b> Piglet production farms to optimize labour and other inputs	-Increase output -Increased production efficiency	-Increase price of piglets by 10%
Extend access to AI services to 50% through establishment of district studs, increasing semen production in existing semen production centres	-Increased fertility -Reduced incidence of reproductive diseases -Reduced inbreeding -Improved performance due to hybrid vigor	-Increase volume of live pigs supplied to the market by 48%
Animal identification and registration system		-Increase exports of processed pork products by 10%
<b>Pig feed production</b>		
Build technical capacity for pig feed processing Support infrastructural development Support establishment of feed processing factories	-Improved processed feed quality and availability	-13 fold increase in feed processing jobs created (10 factories X 30 persons = 300 jobs)
<b>Pig marketing</b>		
Market platforms such as digital marketplace, production contracts and aggregated markets	-Reduce transaction costs	-Increased local consumption of pork and processed pork products -Jobs in marketing and processing
<b>Transport, slaughter and processing</b>		
Licensed carrier vehicles for live pigs	-Reduce losses associated with mortality and injuries	-10% gain in earnings from reduced spoilage losses
Price incentives to pig traders and farmers to channel their pigs to licensed	-Increased slaughter volumes with benefits from economies	-Increased sales volumes at retail

slaughterhouses to optimise their use	of scale	
Extend processing technology through capacity building	-Increased volumes of processed products	
<b>Retail and consumption</b>		
Growing markets through marketing campaigns, advertising	-Increased consumer awareness -Increased domestic consumption of processed pork products	

**Table 32 Proposed technological interventions to promote product differentiation and quality**

<b>Proposed technological intervention</b>	<b>Outcome</b>
<b>Production</b>	
Upgrade to intensive systems to optimise on management	-Improved herd performance -Reduced incidence of mortalities due to infectious diseases -Reduced losses due to condemnation due to zoonotic cysticercosis
Optimise to breed selection based on performance	-Improved carcass quality (back fat thickness, loin eye size, marbling)
Upgrade digital tagging systems	-Forms basis for traceability system
<b>Slaughter</b>	
Upgrade slaughterhouses to facilitate 24 hour holding and hydration of pigs prior to slaughter	-Improved post-harvest handling quality
Upgrade to humane stunning using CO or electric current	-better meat pH after slaughter with better meat quality, less discoloration and lower incidence of pale soft exudative (PSE) pork
Upgrade to Vertical hoisting and carcass suspension system	-Allow for complete bleeding -Reduces surface contamination -Reduces human contact -Avoids contamination of carcass with gut contents -Facilitates easier meat inspection
Upgrade to piped hot and cold water systems	-Increased efficiency bristle removal and carcass cleaning
Upgrade post-harvest handling technology through use of blast chillers and freezers	-Achieves quick drop in carcass temperature thus helps in retaining colour and pH at about 5.7
<b>Processing</b>	
Upgrade processing facilities to comply with stipulated standards such as HACCP, OIE and SEIA procedures	-Improved export earnings
Optimize processing technology through increasing physical infrastructure and building capacity in processing sausage, bacon, ham, salami, special cuts	-Increased volumes of processed products
Optimise market opportunity through research and innovation to diversify products	-Benefit from a larger product base
<b>Retail and consumption</b>	

Upgrade packaging for purposes of branding and quality assurance	-Improved consumer perception resulting in higher sales
Optimise operations by investing in proper storage facilities	-Reduced transaction costs associated with delivery -Reduces losses associated with altered taste/ flavour
Upgrade meat outlets through licencing and enforcing public health and hygiene measures	-Improved consumer perception resulting in higher sales
<b>Enabling environment</b>	-Improve capacity for disease control through surveillance -Development of a national animal breeding policy -Improve the business environment (licencing and taxation) -Enforcement of traceability systems and quality standards -Facilitate access to technology and technical capacity through NIRDA

**Table 33 Matrix showing technological/technical gaps and their interventions**

SN	Value chain node	Needed technological/technical interventions	Source of technology
1	<b>Production</b>	<b>Upgrade to intensive systems</b> to optimise on management: this requires technical support to progressive farmers to acquire modern animal sheds, improved exotic boars/sows.	1) Local model farmers who already have good genetic breeds 2) Importing exotic breeds from regional/international markets
		<b>Extend access to AI services to 50%</b> through establishment of district studs, increasing semen production in existing semen production centres. This requires technical support in form of equipment for semen production and conservation, capacity building through training artificial inseminators.	1) Equipment shall be outsourced 2) Trainings shall be done by local technicians, who have been trained by RAB and other breeding centres (Kisaro, UR-CAVM) in support of international trainers.
		<b>Animal identification system.</b> This can be done at every farm, starting with model farmers.	Developed countries have adopted various identification systems.

		<p>Since individual identification is very costly, herds identification is the best to start with.</p>	<p>However, the best to start with in the Tatoo and ear notches, which are very cheap compared to others.</p>
		<p><b>Support breeding centres.</b> Production of semen extenders using local ingredients needs to be investigated on through research and development. Longer semen storage technology needs to be supported by providing equipment and technical support through trainings.</p>	<p>Based on the existing technologies in developed countries, it is possible to produce some local supplies.</p>
2	Transportation	<p><b>Construction of local pig markets.</b> This requires technical support to build live pig markets in every district. Construction of markets can start in the district where pig farming is mostly practiced. Local administrative authorities in collaboration with RAB should identify the sites of the market.</p>	<p>Market models can be made in accordance with the national requirements as for other livestock markets in the country.</p>
		<p><b>Licensed carrier vehicles for live pigs.</b> The government needs to establish laws/regulations on live pig transportation. Technical support is needed to provide appropriate carrier vehicles for live animals, since pigs require special attention compared to other livestock species. It is also important to construct some aggregation points to reduce long distance before the animals are packed in vehicles.</p>	<p>Reference should made to countries that are advanced in pig production.</p>
3	Slaughter	<p><b>Construction of modern slaughterhouses.</b> According to</p>	<p>The local context should be based on to customize the</p>

		the nature and capacity of the desired slaughterhouse, there is need for technical support in constructing standard slaughterhouses where they are not.	different set-ups and standards of the slaughterhouses.
		<b>Upgrade slaughterhouses.</b> For the existing slaughter facilities, it is important to upgrade to standard slaughterhouses by providing machinery and other required technical support to ensure quality pork meat after slaughtering.	Machinery should be outsourced. Other supplies such as hinging lines shall be sourced from the local market.
		<b>Upgrade post-harvest handling technology.</b> This needs provision of cooling facilities (such as freezers, and blast chillers).	Cooling facilities (freezers and chillers) may be internally sourced or outsourced.
4	Processing	<b>Provision of processing machinery.</b> Technical support in form of cutting equipment, storage facilities (freezer), processing machinery for various products (sausage, bacon, ham, salami, etc.), packaging technology.	Some of the machinery can be outsourced, others are locally available.
		<b>Upgrade processing facilities</b> to comply with stipulated standards such as HACCP, OIE and other procedures. There is also a need for capacity building in terms of various standards for quality compliance and export purpose.	
		<b>Optimise market opportunity</b> through research and innovation to diversify products. It is also important to support processors in Research and Development	Local research institutions (University of Rwanda, IPRC, RAB) should be used to provide technical support.

		for the purpose of products diversification.	
5	Retail and consumption	<b>Optimise operations</b> by investing in proper storage facilities. This needs provision of cooling facilities (such as freezers, and blast chillers).	Cooling facilities (freezers and chillers) may be internally sourced or outsourced.
		<b>Upgrade packaging</b> for purposes of branding and quality assurance. Provision of packaging materials for better marketing and storage purposes.	Locally available
		<b>Upgrade meat outlets</b> through licencing and enforcing public health and hygiene measures. This needs capacity building thought training.	Local provision
6	Pig feed production	Support infrastructural development	Some of the machinery can be outsourced, others are locally available. Technical support shall be locally sourced. Non-conventional feed sources (Use of maggots, <i>Urtica dioica</i> = common nettle, etc.) need research and development to reduce the high price of animal feeds.
		Support establishment of feed processing factories	
		Build technical capacity for pig feed processing and use of locally available feed ingredients	

#### 6.4 Potential benefits from upgrading, extending and optimising technology

The LMP, 2017 proposed a roadmap for improvement of pig production from 19,945 tonnes in 2017/2017 to 67,076 tonnes in 2021/2022. This will raise the GDP from pig meat by 214% from RWF 21,072 to RWF 66,266 billion. To achieve this, coordinated improvement in key areas in production processing, marketing and other support services are necessary.

## **CHAPTER SEVEN**

### **CONCLUSION AND RECOMMENDATIONS**

#### **7.1 Conclusion**

The Technology audit of the Pig Value Chain in Rwanda was carried out to establish the current state of technology, existing technology gaps and the potential for upgrading, extending and optimising technology in the entire value chain. To achieve this, the study used secondary data from relevant government institutions and primary data from value chain actors. Focus group discussions and key informant interviews were used to triangulate the findings from quantitative data analysis.

#### **Key findings**

##### **a) Overview**

- Pig farming in Rwanda has grown by 76% in the last 5 years with the number of pigs increasing to over 1.7 million.
- The pig industry is projected to grow by increasing the number of fattening piglets to 266,251 and pork production to increase to 39,805 tonnes over the 5-year period with an increase of 214% increase in pork's contribution to GDP.
- Pork constitutes 21% of all dressed meat in Rwanda
- The demand for live pigs is large; 25,920 head of pigs are exported monthly to the DRC
- The demand for processed meat products in the DRC though lucrative, is insatiable and meat processors in Rwanda need to take advantage of it.

##### **b) Technology gaps**

###### ***At production***

- Production systems are mainly the indigenous family pig system in either intensive, semi-intensive or extensive systems with need for better housing to improve pig comfort, improve efficiency of resource use and optimise on disease control
- Record keeping was not done at all in over 40% of pig enterprises
- Pig breeding is currently characterised by high levels of inbreeding and lack of a structured system of breed improvement resulting in unfavourable bio-economic indicators (age at first farrowing, farrowing interval, litter size, pre-weaning mortality)

- Use of artificial insemination in breed improvement is limited to the Northern Province near semen production centres in Rulindo district-Kisaro centre and Musanze district-Busogo centre, at the University of Rwanda
- Control of internal and external parasites and administration of iron injection to piglets were carried out by about 50% of producers indicating a gap in disease control
- There was wide use of non-conventional feedstuff to feed pigs. These included by-products of grain milling (85.3%), green fodder (83.1%), home-made feeds (63.8%), institutional swill (62.6%) and post-harvest farm residue (60.7%), most of which are low value in terms of meeting the nutrient requirements of pigs
- 92.2% of farmers obtained extension information from other farmers which was associated with ease of access compared to government extension services

A combination of these gaps resulted in poor productivity in pig enterprises due to low fertility, high mortality and low production potential of existing breeds; despite a favourable gross margin of 34%.

#### ***At marketing and transport***

- 81% of producers sold pigs to live pig markets via intermediaries while only 10.2% sold to processors including slaughter slab owners
- 58% of traders transported pigs on foot; there was limited vehicle transport

#### ***Slaughter and processing***

- Only 2 licenced pig slaughterhouses with HACCP certification
- Limited technical and human resource capacity for processed pork products
- Lack of holding facilities
- 70% of pork in butcheries from home slaughter with no inspection
- 100% of slaughter in slabs performed on floor, traditional stunning by heavy blow on head
- 100% of slaughter slabs –use machetes to portion pork and cut bones
- Lack of chilling or freezing facilities
- Inhumane slaughter

#### ***Consumption***

- 16.9% of consumers dislike pork due to poor quality
- Low processed product knowledge among consumers with sausage and bacon being most preferred

- No special meat cuts in butcheries

**c) Proposed interventions to upgrade, extend and optimise technology**

***At production***

1. Upgrading to intensive systems with the objective of increasing total annual pork production to 67 metric tonnes through:

- Specialised piglet multiplication centres to produce piglets for commercial fattening centres as well as for sale to other producers/farmers
- Establishment and expansion of piglet fattening centres for supply of mature pigs for the pork market
- Expanding livestock advisory services on pig reproduction, housing, feeding, recording and general management practices. This can be achieved through extension methods such as farmer-to-farmer approach, farmer field schools and functional literacy programmes
- Establishment of a centre of excellence for building capacity in pig breeding and production management, promotion and up scaling of promising technologies, research, incubation and dissemination of technologies and building linkages with other value chain actors
- Reproductive management technology to optimise piglet production
- Piggery business hubs to aggregate producers in cohorts with the common interest of providing training, increasing access to inputs, availing credit services and coordinating marketing.

2. Genetic improvement through:

- Establishing and rolling out a national pig breeding programme and a national herd registration programme
- Importing boars
- Increasing access to artificial insemination services by linking provincial centres district studs, training of farmers and inseminators, establishing pig farmers clusters of to aid in AI planning and promoting private sector participation in AI service provision.

To meet the anticipated demand for boar semen of approximately 207,918 doses annually while remaining profitable, there will be a need to upscale production by having 3 studs each hosting 60 – 70 boars.

***At transport***

-Enforcement of transport licencing stipulating:

- Appropriate vehicles that ensure animal comfort
- Origin and destination of pigs
- Appropriate time for transport

### ***At slaughter and processing***

Existing and licensed slaughterhouses need to be upgraded by providing technical assistance including;

- Capacity building in meat processing,
- Architectural designs for abattoirs,
- Machinery and equipment for quality checks and traceability. Such equipment would include: stunning equipment (electric), hoist (manual or electric), scalding vat and dehairing machine, scrapping/ gambrelling table (stainless steel), electric splitting saw and breastbone saw.
- Use of bio digesters would be an innovative approach in managing waste.
- Cold chain technology

### ***At consumption***

To increase access to a variety of wholesome, presentable and competitive products to the consumer and to increase sales volumes for vendors, technological intervention shall focus on;

- v) Increasing the product range to diversify consumer choice
- vi) Creating product knowledge through advertising campaigns
- vii) Quality assurance through formalising retail pork trade, licencing and enforcement and hygiene
- viii) Meat storage technology such as freezers and cold-rooms
- ix) Innovative packaging and product presentation
- x) Product branding
- xi) Market segmentation

### **d) Projected annual outcomes of upgrading, extending and optimising technology**

- 7240 smallholder enterprises upgraded to modern intensive system
- 48.2% increase in live pig sold for the pork market with a value of USD 14,328,904
- 10% increase in value of processed products with a value of USD 3,729,385
- A 13-fold increase in pre-formulated feed production with a value of USD54,355,319

- Increase in income from formal on-farm employment with a value of USD 1,127,774
- 50% increase in employment (private and public) in the animal health service sector with a value of USD 702,425
- 400 direct jobs in animal feed processing

## **7.2 Recommendations**

This section provides a summary of recommendations from the Technology audit of the piggery Value Chain.

### **7.2.1 Recommendations for policy**

1. Strengthening the enabling environment through;

- Coordination of animal health services offered by the public and private sector to ensure synergy in disease control efforts
- Strengthening the national disease control programme for all livestock with particular consideration of highly infectious and zoonotic diseases like African swine fever (ASF) and Swine cysticercosis.
- Encourage continuous professional development among livestock healthcare workers to build their capacity in disease identification and management.
- Strengthening knowledge management and transfer through facilitating establishment of farmer field schools and functional literacy programmes
- Strict enforcement of quarantine measures
- Enforcement of fair-trade practices to limit exploitation of producers
- Formalisation of pig markets by ensuring trade contracts are honoured
- Mainstreaming gender and youth inclusivity for example through;
  - Improving access to microfinance to women through creation of a Women development fund that can be a source of credit;
  - Promoting parallel technologies that benefit women such as biogas
  - Empowerment through trainings in local women and youth groups,
  - Design funding proposals that favour access by women and youth,
  - Set requirements for training such that women and youth are not left out
- Mainstreaming youth and employment in agri-food chains through;

- Institutionalising innovation platforms
- Promoting the use of IT to develop solutions to challenges in the value chain
- Advocacy for inclusion of youth in employment policy
- Youth involvement in technical training programmes such as AI, feed processing and meat technology
- Mainstreaming sustainable environmental management and climate change through enforcing
  - Requirement for an environmental audit in all investments.
  - Promotion of climate smart technologies that reduce emission of greenhouse gases (GHG)
- Mainstreaming decent work agenda as per the United Nations Sustainable Development Goal No.8

## 2. Recommendation for Government investment

- e) Technical and human resource capacity in quality evaluation of meat and processed meat products, animal feeds and feed additives and traceability systems as a catalyst for investment
- f) Public-Private Partnerships in investments that require large capital outlays and those that are often less profitable including;
  - Establishment of large volume export slaughterhouses
  - Establishment of breeding centres, centre of excellence and district studs
  - Infectious disease control and surveillance;
  - Market intelligence/ survey;
  - Establishment of a national livestock breeding strategy
  - Inspection of compliance to market standards and certification
- g) Through NIRDA's support

### **7.2.2 Recommendations for investment and technical support**

#### 1. NIRDA – through use of open calls NIRDA could invest through;

- Logistical and technical support in acquisition of relevant technologies in pig production, processing, marketing and consumption
- Capacity building through acquisition of technical capacity or strengthening existing capacity.

Support to private sector investment could be directed towards

- Pig breeding centres for breeding pigs and artificial insemination
- Piglet multiplication centres
- Piglet fattening/ finishing establishments
- Pig slaughtering facilities for export grade pork
- Pork processing facilities for production of high value products
- Logistics
- Animal health and animal input supply

## 2. Business support services that NIRDA can provide

Infrastructural support to enterprises should go together with capacity building in soft skills to ensure a holistic approach to business support. The following are areas where NIRDA can provide training to so as to optimise management efficiency;

- Development of business/ investment plan
- Basic business accounting
- Business finance
- Marketing
- Business/ livestock insurance
- Quality standards and quality certification

### **7.2.3 Recommendations for further research**

This study recommends the following for further research;

- Potential for local production of semen extenders with the aim of reducing the cost of AI
- The potential of using indigenous breeds of pigs in development of a breed adapted for the local environment
- Nutrient and feeding values of various locally available feed resources to establish potential benefits
- -Innovation of value-added pork products that could be patented

## **CHAPTER EIGHT**

### **GUIDELINES FOR THE NIRDA OPEN CALLS**

#### **8.1. Rationale**

The objective of this study was to assess potential for upgrading technology use in the Piggery Value Chain (PVC) by evaluating the available technology in the PVC and its potential to strengthen the effectiveness and efficiency of the PVC. The study also evaluated the potential to extend existing and new technologies by identifying technology constraints along the chain and proposed key interventions. The study then identified potential industry players who would benefit from the technology support from NIRDA to optimize their operations to make them more competitive with the objective of increasing the value of products sold locally and for export.

Findings from the Technology Audit of the Piggery Value Chain in Rwanda brought to light challenges and gaps in the value chain; from input suppliers to processors. These gaps are in form of technology, knowledge and technical aspect of the value chain. To intervene in addressing such gaps, NIRDA uses the “Open Calls” approach to provide technical and logistical support to existing enterprises with high potential for upgrading, extending and optimising operations to improve efficiency and becoming more competitive. This study proposed guidelines to assist NIRDA’s Open Call Selection Committee in identifying and selecting candidate enterprises along the PVC with the highest potential.

#### **8.2 Proposed guidelines and eligibility criteria for piggery Open Call**

These guidelines were developed based on the technology gaps identified in the PVC and the specific nature of the value chain function. The basic requirements for NIRDA were also considered, where the candidate enterprise must have been in existence for at least 2 years.

##### **8.2.1. Guidelines for input suppliers**

Input suppliers include all actors in the PVC who provide primary materials for purposes of pig production. These include but not limited to; breeding centres (producers of breeding sows and boars, semen production centres and piglet multiplication centres), veterinary service providers (agro-vet shops, veterinary practitioners) and animal feed factories. The proposed eligibility criteria for open calls for input suppliers were suggested as follows:

a) **Breeding centres**

Technology needs include: quality breeds of breeding pigs, animal identification and record keeping technology (Digital Pig Management Systems (DPMS) modern farm structures to ease herd management and pig handling. The proposed eligibility criteria were as follows;

- Be the owner of the farm,
- Be registered with MINAGRI as a breeder
- Be a registered member of pig breeders association (once in existence)
- Have the capacity to maintain these animals in good conditions,
- Have enough land to rear pigs,
- Be able to adopt IT tools (phones, computers) for the DPMS.
- Conduct a Socio-economic environmental impact evaluation for the project
- Have a business plan to evaluate viability of the investment

b) **Semen production centres**

Technology needs include: semen collection, handling and processing infrastructure including testing laboratories and laboratory equipment, materials such as semen extenders, packaging material and insemination equipment. Technical capacity for use of these technologies would also be considered.

*The proposed eligibility criteria were as follows;*

- Be individual pig breeder, farmer cooperative or a private company, registered and recognized by the Rwandan law establishing private companies,
- Publicly funded institutions with livestock production affiliation are eligible,
- Public Private Partnerships (PPPs) are eligible
- Be a registered member of pig breeders association (once in existence)
- Have the capacity to maintain these animals in good conditions,
- Have enough land to rear pigs,
- Be able to adopt IT tools (phones, computers) for the DPMS.
- Conduct a Socio-economic environmental impact evaluation for the project
- Have a business plan to evaluate viability of the investment

**c) Veterinary practitioners**

Veterinary service providers (mainly private practitioners) need capacity building (training in artificial insemination).

The proposed eligibility criteria were as follows;

- Be a licenced practitioner by the Rwanda Council Veterinary Doctors
- Be familiar with and able to adopt IT tools (phones, computers) for the DPMS
- Business plan to evaluate viability of the investment

**d) Animal feed manufacturers**

The specific technology and capacity needs for feed manufacturing include; technical capacity for feed formulation, testing capacity for quality of raw materials, machinery and access to special feed ingredients that are not locally available.

The proposed eligibility criteria were as follows;

- Be a registered company or a farmers' cooperative
- Be registered with MINAGRI as an animal feeds manufacturer
- Be a member of an association of feed manufacturers in Rwanda (where it exists)
- Be RSB and/or Rwanda FDA certified for compliance with quality standards
- Be RRA compliant,
- Meet the minimum requirements for qualifications of key human resource needs
- Conduct a Socio-economic environmental impact evaluation for the project
- Have a business plan to evaluate viability of the investment
- Have a gender equality policy.

**8.2.2. Live pig transport**

Technology, technical capacity and logistical challenges encountered in live pig transport and slaughter were associated with significant losses due to injuries, fatigue and exhaustion of pigs leading to poor quality pork with compromised storage quality. Support would therefore be in form of acquisition of appropriate animal transport vehicles or upgrading of existing ones.

The proposed eligibility criteria for NIRDA's support to live pig transport was as follows;

- Be registered as a transporter
- Be RRA compliant
- Have a business plan to evaluate viability of the investment

### **8.2.3. Pig slaughter and processing**

The specific technology and capacity needs for feed manufacturing include; technological capacity for humane killing, good hygiene at slaughter, packaging, storage, product differentiation and marketing. These functions are also characterised by gaps in human resource with need for capacity building.

The proposed eligibility criteria for NIRDA's support to meat processors includes;

a) For existing slaughterhouse operators:

- Be a registered company
- Be registered by Rwanda FDA and certified for compliance with quality standards
- Be compliant with RRA
- Be compliant with public health requirements for staff
- Meet the minimum requirements for qualifications of key human resource for food processing plants
- Present a business plan for investment
- Have capacity for IT use or upgrading
- Have sufficient land for the slaughterhouse or processing factory
- Slaughterhouse and processors must comply with all requirement for sustainable environmental management.
- Have a product development policy/procedures (SOP)
- Have a gender equality policy

b) For new (start-ups) operators:

- Be a registered company
- Be registered by Rwanda FDA as a food processor
- Be compliant with public health requirements for staff: Meet the minimum requirements for qualifications of key human resource for food processing plants
- Present a business plan for investment
- Have capacity for IT use or upgrading
- Have sufficient land for a slaughterhouse or processing factory
- Slaughterhouse and processors must comply with all requirement for sustainable environmental management.

- Have a product development policy/procedures (SOP)
- Comply with gender equality policy

#### **8.2.4 Wholesale and retail of pork and pork products**

Technology needs for pork traders include the need to preserve pork and pork products in a hygienic manner and to create a perception of a high-quality product among consumers. The proposed eligibility criteria for NIRDA's support will include;

- Have a registered premise
- Compliance with requirement for sustainable environmental management.
- Compliance with public health requirements for staff
- Compliance with RSB standards for meat outlets
- Compliance with RRA

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### APPENDIX I: LIST OF KEY INFORMANTS

	<b>Names</b>	<b>Institution</b>	<b>Position</b>	<b>Phone number</b>
1	Tuyambaze Emmanueel	Muryabazira Pig slaughter slab	SARO, Cyabingo sector	0788290857
2	Ndagijimana Celestin	Rwanza Pig slaughter slab	SARO, Rwaza sector	0783963757
3	Shumbusho Benjamin	UR-CAVM Semen centre	Veterinary Technician	0788738512
4	Mugabarigira Celestin	Nkotsi pig slaughter slab	Owner	0783337169
5	Mukanyamibwa Melanie	CPPA Kisaro breeding centre	Technician	0783108125
6	Hakizimana Casmir	Rugali Meat Processing Company	Veterinary Technician	0785218246
7	Dr Hirwa Claire d'André	RAB	Research Fellow	0784824250
8	Mr Christian Harmans	Enabel		0787211588
9	Kamugisha Samuel	MINICOM	DG- Industry and Entrepreneurship Development	0788845648
10	Nshimiyimana Ossiniel	MINICOM	Community Processing Centers Specialist	0788616102
11	Harerimana Emmanuel	Muyumbu Breeding centre	Owner	0788426538
12	Shirimpumpu Jean Claude	Rwanda Pig Farmer Association (RPFA)	Chairperson	0788590416
13	Augustin SEBAKAMBWE	Enable		0788358091
14	Celestin MYAMBI	Enabel		
15	Amandin MIHIGO	NIRDA		0788503323
16	Serge MBARAGA	NIRDA		0788304698
17	Annette MUKAYIRANGA	NIRDA		
18	Rukundo Jean Claude	RAB		0785675817
19	Shema Aimable	NAEB		0788758226

## APPENDIX II: LIST OF FOCUSED GROUP DISCUSSIONS AND PARTICIPANTS

No	Names	Province	District	Phone Number
1	Uwamahoro Clementine	North	Gicumbi	0789456093
2	Kabanyana Martine	North	Gicumbi	0728815289
3	Uwizeyimana Odette	North	Gicumbi	0727333025
4	Muhayimana Anathalie	North	Gicumbi	0787405408
5	Niyigaba Theogene	North	Gicumbi	0728578708
6	Nganizi Jean Bosco	North	Gicumbi	0789774881
7	Munyampeta	North	Gicumbi	07284567995
8	Safari Dieudonne	North	Gicumbi	0783790586
9	Twahirwa J.M. V	North	Rulindo	0780700454
10	Hatangimana Venuste	North	Rulindo	0788260428
11	Mugwaneza Didace	North	Rulindo	0782209286
12	Murwanashyaka	North	Rulindo	0781202745
13	Biziyaremye J. Claude	North	Rulindo	0788523567
14	Habiyambere Evode	North	Rulindo	0788013575
15	Mabuye	North	Rulindo	N/A
16	Mukandayisaba Godelive	North	Rulindo	0785557576
17	Muhire J.M. V	North	Rulindo	N/A
18	Nyagatare Bonaventure	North	Rulindo	0787301429
19	Sibomana Paul	West	Nyamasheke	0788758889
20	Niyonkuru Denyse	West	Nyamasheke	0785770801
21	Munganyinka Goreth	West	Nyamasheke	0789817090
22	Mukabutera Stephanie	West	Nyamasheke	0782113013
23	Tuyishime Noa	West	Nyamasheke	0780419849
24	Nshimiyumukiza JMV	West	Nyamasheke	0782432367
25	Mukamugema Alphonsine	West	Nyamasheke	0787777515
26	Mukakabango Antoinette	West	Nyamasheke	0787871270
27	Uzayisenga Francoise	West	Nyamasheke	0787731815
28	Ntwari Modeste	West	Nyamasheke	0785093282
29	Safari Emmanuel	South	Muhanga	072353120
30	Nyirangendahimana Sarah	South	Muhanga	N/A
31	Mushimiyimana Delphine	South	Muhanga	0786749324
32	Niyitegeka Emmanuel	South	Muhanga	0789542621
33	Tuyizere Innocent	South	Muhanga	0780372166
34	Mizero Oscar	South	Muhanga	0785284759
35	Habimana Innocent	West	Rubavu	0782269409
36	Hategetsimana Mishack	West	Rubavu	0781493071

37	Habimana Emmanuel	West	Rubavu	0785437070
38	Munyanyiko Jean. D	West	Rubavu	0781642510
39	Gasigwa Noel	West	Rubavu	0782330045
40	Havigimana Simon	West	Rubavu	0787706384
41	Nshimiyimana Emmanuel	West	Rubavu	0788864235
42	Manizabayo Masoda	West	Rubavu	0787410592
43	Dushimirimana Davi	West	Rubavu	0788975098
44	Habarugira Johnson	West	Rubavu	0789366791
45	Habiyambere Evariste	South	Nyamagabe	0789414310
46	Nyirandihano Florentine	South	Nyamagabe	0784954371
47	Mukamana Euphrasie	South	Nyamagabe	0782143873
48	Nikuze Florida	South	Nyamagabe	0725737582
49	Musabyimana Rose	South	Nyamagabe	0726301636
50	Uwineza Felcien	South	Nyamagabe	0725676554
51	Habyarimana Mathias	South	Nyamagabe	0784987271
52	Nyirahabimana Marie	South	Nyamagabe	0723792939
53	Mukarukundo Francoise	South	Nyamagabe	0787558133
54	Mutuyimana Devothe	South	Nyamagabe	0727533005
55	Ngendahayo Gaspard	West	Rusizi	722160313
56	Mukandamage Thansilla	West	Rusizi	785453910
57	Nikwigize Malachie	West	Rusizi	788376045
58	Uzayisenga Beatrice	West	Rusizi	783576147
59	Nzeyimana Eric	West	Rusizi	788207059
60	Uwimana Jmv	West	Rusizi	782649208
61	Karenzi Valens	West	Rusizi	724510066
62	Tuyisenge Herniette	West	Rusizi	785143036
63	Karenzi Jmv	West	Rusizi	725001965
64	Habimana Theogene	East	Bugesera	786404261
65	Nzabamwita Emmanuel	East	Bugesera	789439356
66	Bampire Esperance	East	Bugesera	783393803
67	Munyashyaka Valens	East	Bugesera	788720554
68	Nzabarantumye Gerard	East	Bugesera	783218870
69	Turikumana Phocus	East	Bugesera	788476405
70	Ndayisabye Dieu Donne	East	Bugesera	783789744
71	Ufiteyezu Yobu	East	Bugesera	783614906
72	Hakizimana J.Pierre	East	Bugesera	78310799
73	Simbi Dalia	Kigali	Gasabo	0787154175
74	Zikuzani Lambert	Kigali	Gasabo	0787108383
75	Mugabowindekwe Donatien	Kigali	Gasabo	0788656922
76	Pt Semainre Ndera	Kigali	Gasabo	0783033385
77	Bwanakweli Jean Felix	Kigali	Gasabo	0788525785

78	Habagenzi Raphael	Kigali	Gasabo	0788516722
79	Byaruhanga	Kigali	Gasabo	0783487652
80	Yvas Ngateu	Kigali	Gasabo	0782675827
81	Havugiyaremye Alphonse	East	Rwamagana	0788425345
82	Musabyimana Vestine	East	Rwamagana	0783181920
83	Ngabonziza Emmanuel	East	Rwamagana	0784856743
84	Twiringiyiman Vedaste	East	Rwamagana	0782150576
85	Kandenzi Beatha	East	Rwamagana	0784220463
86	Nidufashe Alexis	East	Rwamagana	0785523127
87	Kwizera Pacifique	East	Rwamagana	0780950050
88	Nkurunziza	East	Rwamagana	0782864221

**APPENDIX III: LIST OF PARTICIPANTS IN HOUSEHOLD SURVEY**

	<b>NAME OF RESPONDENTS</b>	<b>PHONE NUMBER</b>	<b>District</b>	<b>Latitude</b>	<b>Longitude</b>
1	Mugabo Claude	786177744	Gicumbi	-1.615712	30.079603
2	Garurinyana Chantal	725208351	Gicumbi	-1.618268	30.070258
3	Nganizi Jean Bosco	789774881	Gicumbi	-1.634100	30.087270
4	Habimana Samuel Seth	788577674	Nyamasheke	-2.449003	29.043047
5	Niyigaba Theogene	785787084	Gicumbi	-1.639240	30.089297
6	Kayitare Emmanuel	783388739	Bugesera	-2.113745	30.103978
7	Twizeyimana Viateur	785298990	Bugesera	-2.114652	30.103148
8	Niyihaba J. Daniel	783377668	Bugesera	-2.115080	30.102528
9	Uwamahoro Clementine	789456093	Gicumbi	-1.642002	30.087470
10	Turinumukiza J. Damascene	781088267	Bugesera	-2.110938	30.102733
11	Ngendahimana Anastase	784972752	Rubavu	-1.674400	29.287918
12	Hakizimana Innocent	788850013	Rubavu	-1.673758	29.288148
13	Ruyingingo Raphail	783205782	Rubavu	-1.674352	29.287687
14	Nsengiyunva Faustin	785254401	Rubavu	-1.674607	29.287963
15	Maniriho JMV	785726666	Rubavu	-1.675467	29.287095
16	Turatsinze Marcel	781549349	Rubavu	-1.676570	29.287440
17	Nkubito Avit	788617473	Rulindo	-1.642074	30.022017
18	Nkurunziza Charles	781861960	Rulindo	-1.639845	30.022254
19	Simba Dalia Samantha	787154175	Muhanga	-1.950105	30.171049
20	Mukambanda Alexiane	786695800	Rusizi	-2.584103	28.927217
21	Habimana Emmanuel	788890377	Rusizi	-2.598020	28.923543
22	Bigirabagabo Emmanuel	783033385	Gasabo	-1.950072	30.171097
23	Frere De La Charite	785617596	Gasabo	-1.952744	30.171707
24	Ruzigamanzi Thacien	783334235	Nyamagabe	-2.507472	29.481340
25	Umugwaneza Julienne	783199016	Nyamagabe	-2.507593	29.481425
26	Imanirareba David	788500176	Rusizi	-2.449998	28.907067
27	Ndayambaje Rugema Venuste	783333922	Nyamagabe	-2.526855	29.484827
28	Nyiranziza Jeanette	786918716	Nyamagabe	-2.526752	29.485245
29	Habiyambere Nestol	785281460	Rusizi	-2.447378	28.902685
30	Gasper Ariku	784769504	Rusizi	-2.446857	28.902660
31	Hagenimana Manasseh	780684279	Rusizi	-2.453960	28.900895
32	Senyombya Jean Damascene	788654687	Rusizi	-2.447697	28.905425
33	Frère Niyonkuru Dieudone	788621541	Gisagara	-2.599477	29.740878
34	Dusabe Agnes	788554411	Gisagara	-2.564985	29.715647
35	Mukantwari Venancie	735327505	Gisagara	-2.539302	29.766589
36	Nsengiyumva J Piere	726932143	Gisagara	-2.539302	29.766589

37	Umugwaneza Ivette	785461080	Gisagara	-2.593076	29.769864
38	Habinshuti Emmanuel	786833095	Gicumbi	-1.612432	30.087580
39	Mbarushimana Vedaste	781945158	Gisagara	-2.575498	29.761589
40	Mutabazi Emmanuel	722082411	Gisagara	-2.575498	29.761589
41	Uwera Eugenie	788430208	Gicumbi	-1.612940	30.086782
42	Karekezi Joseph	784693646	Gisagara	-2.575498	29.761589
43	Barinda J. Claude	786975751	Bugesera	-2.127137	30.120598
44	Vuguziga Mediatrice	788470467	Bugesera	-2.121853	30.145215
45	Gakwaya Anastase	722808342	Bugesera	-2.120362	30.147022
46	Gatsefano Joseph	783293081	Bugesera	-2.121860	30.147462
47	Nzabamwita Emmanuel	789439356	Bugesera	-2.150855	30.145130
48	Habimana Theogene	786404261	Bugesera	-2.151223	30.145242
49	Mugiraneza Laurent	783393803	Bugesera	-2.148625	30.144343
50	Iragena Peter	789110245	Bugesera	-2.128847	30.123507
51	Niyomuhoza Abigayile	783203811	Bugesera	-2.129655	30.124712
52	Hellen	788374001	Gasabo	-1.942398	30.176928
53	Byaruhanga Inergon	783487652	Gasabo	-1.947622	30.179219
54	Yves Simeu Ngateu	782675827	Gasabo	-1.933383	30.175280
55	Hababagenzi Rafael	788516722	Gasabo	-1.947438	30.169249
56	Bwanakweli J Felix	785257888	Gasabo	-1.949943	30.167051
57	Mukashyaka Cloudine	787963785	Gisagara	-2.575498	29.761589
58	Nsengiyumva Israel	725031030	Nyamagabe	-2.507265	29.481193
59	Mirimo Culiofance	788670024	Nyamagabe	-2.507147	29.481168
60	Sibomana Paul	788758889	Nyamasheke	-2.438702	29.022087
61	Mukahirwa Clementine	784193341	Nyamasheke	-2.449675	29.043977
62	Nshimiyimukiza Jean Marie Viane	782432367	Nyamasheke	-2.439308	29.021217
63	Ntirandekura Honore	787514477	Nyamasheke	-2.439887	29.027062
64	Nzeyimana Thaddée	783726070	Nyamasheke	-2.450483	29.042770
65	Nshimiyimana Jbosco	788805849	Gisagara	-2.575498	29.761589
66	Gashema J.B	788608927	Rubavu	-1.661732	29.273497
67	Bizimana Elias	788468673	Rubavu	-1.662570	29.273308
68	Akimanizanye Christine	789905351	Rubavu	-1.666437	29.283190
69	Habiyaremye Emanuel'	783426668	Rubavu	-1.667852	29.284700
70	Manizabayo Sado	788975098	Rubavu	-1.646430	29.283573
71	Ntirenganya Aloys	788683360	Rubavu	-1.635095	29.294285
72	Twizerimana Vedaste	783606184	Rubavu	-1.635350	29.295337
73	Havugimana Simon	788864235	Rubavu	-1.643928	29.282848
74	Mwerekande Anastase	786030778	Rulindo	-1.629555	30.029054
75	Rutikanga J.Babtiste	783276981	Rulindo	-1.629373	30.033434
76	Mujyawariya Immaculate	726388590	Rulindo	-1.629821	30.033089
77	Ntibiramira Pascal	783796735	Rulindo	-1.629300	30.034085

78	Ndahayo Jmarie Vianney	788529338	Rulindo	-1.629966	30.030527
79	Nzabonantuma J. Bosco	722169663	Rulindo	-1.640387	30.048542
80	Manimfashe Kazungu	722264108	Rulindo	-1.640657	30.048755
81	Mfitumukiza Nzatuma Eric	782576651	Rulindo	-1.610541	30.035070
82	Manirakizaje Jean De La Croix	783425471	Rulindo	-1.616372	30.032599
83	Hazitamungu Patrice	788544201	Rusizi	-2.446240	28.905757
84	Uwimana JMV	782649208	Rusizi	-2.586457	28.926243
85	Uwimana Annonciata	787179305	Rusizi	-2.584300	28.927110
86	Baravuga Theoneste	782236708	Gisagara	-2.635894	29.868034
87	Bikiramakuba Jpoul	784215069	Gisagara	-2.516920	29.882463
88	Kanyamabuye Munyampeta	788456795	Gicumbi	-1.605445	30.073223
89	Nkeshiyaremye Augustin	782266447	Bugesera	-2.162415	30.141197
90	Hakizimana J.Pierre	783393745	Bugesera	-2.154723	30.142627
91	Nzabarantumye Gerard	783218870	Bugesera	-2.156935	30.151917
92	Murasandonki Damascene	784261196	Bugesera	-2.184545	30.159382
93	Turikumana Phocus	788476405	Bugesera	-2.189625	30.161642
94	Hanyurwimfura J.Batiste	784096196	Bugesera	-2.183103	30.160873
95	Bizimana J.Claude	785262139	Bugesera	-2.149450	30.147935
96	Uzayisenga Beatrice	783576147	Rusizi	-2.581552	28.926537
97	Karenzi Valens	724510066	Rusizi	-2.580220	28.925528
98	Iyamuremye Adrien	789010810	Rusizi	-2.579812	28.923947
99	Nyirahabimana Domicienne	723876045	Rusizi	-2.578163	28.921140
100	Ngendahayo Gaspard	722160313	Rusizi	-2.579960	28.920703
101	Nishyirimbere Languida	723356746	Rusizi	-2.579377	28.922227
102	Rucyahana Martin	788385689	Nyamagabe	-2.529130	29.520630
103	Maniraho Bernard	781625263	Nyamagabe	-2.537402	29.521888
104	Uwizeyimana Alphonse	788843631	Nyamagabe	-2.506607	29.508785
105	Hitimana Charles	781004559	Nyamagabe	-2.505665	29.504890
106	Nyirarukundo Valentine	785508982	Nyamasheke	-2.449552	29.010698
107	Habyarimana Pascal	788806039	Nyamasheke	-2.454293	29.011332
108	Ntakobatagize Placide	782607468	Nyamasheke	-2.456950	29.003482
109	Rwego J.Baptista	724398007	Rulindo	-1.642921	30.022559
110	Mukarwego Jackline	724742272	Rulindo	-1.642348	30.021781
111	Kabanyana Claudine	727461115	Rulindo	-1.641238	30.021563
112	Habimana Innocent	782269409	Rubavu	-1.646397	29.283465
113	Twibanire Sprien	785809260	Rubavu	-1.641668	29.311603
114	Nsekanabo Aphrodis	783580224	Rubavu	-1.642413	29.310268
115	Dushimirimana Patrick	788696546	Rubavu	-1.621222	29.317213
116	Ayorwanda JB	788466255	Rubavu	-1.629423	29.323467
117	Niyonsenga Theogen	781154350	Rubavu	-1.637458	29.314053
118	Mugabowindekwe Donatien	788656922	Gasabo	-1.946672	30.169309

119	Sikuzani Lambert	787108383	Gasabo	-1.941335	30.172132
120	Habimpano Aleandre	781958520	Gasabo	-1.932737	30.171737
121	Janvier	789646893	Gasabo	-1.935210	30.169058
122	Shirimpumpu Jean Claude	788590416	Gicumbi	-1.605112	30.083017
123	Habinshuti Jean Baptist	786542931	Gicumbi	-1.683257	30.145523
124	Mukantambara Patricia	786833221	Gicumbi	-1.691210	30.149055
125	Manirakiza J Cloude	780574180	Gisagara	-2.587471	29.862515
126	Irimaso Eric	727946273	Gisagara	-2.587471	29.862515
127	Nkorebuke Sylvere	723822209	Gicumbi	-1.687753	30.152688
128	Uwamariya Francois	783718234	Gisagara	-2.587471	29.862515
129	Habinshuti Valens	725801773	Gicumbi	-1.686827	30.154887
130	Habyarimana Alex	726497157	Gisagara	-2.611683	29.865274
131	Izerimana Consesa	725470815	Gisagara	-2.587471	29.862515
132	Mukandutiye Donatille	783832408	Gicumbi	-1.685452	30.153430
133	Muhire Olivier	784088324	Rusizi	-2.616438	29.014867
134	Murekatete Dania	726609507	Rusizi	-2.615287	29.014205
135	Karake Diogène	786729645	Gicumbi	-1.682670	30.147657
136	Nyirandorimana Korotirida	724090235	Gisagara	-2.635894	29.868034
137	Uwamahoro Claudine	729086704	Gicumbi	-1.683352	30.143725
138	Niyoyita Peace	788892051	Bugesera	-2.128412	30.039917
139	Sinamenye Claudio	788692577	Bugesera	-2.133848	30.023092
140	Sebahinzi Charles	788577083	Bugesera	-2.106852	30.042652
141	Kayiranga Athanase	785072880	Bugesera	-2.108420	30.038650
142	Eric	789563538	Bugesera	-2.093900	30.048472
143	Rwamucyo Severien	788351463	Bugesera	-2.084530	30.052048
144	Turbo Gafaranga	780885884	Bugesera	-2.083108	30.056025
145	Munyaneza Pierre	784803979	Bugesera	-2.083695	30.055205
146	Sebahire Athanase	782273635	Bugesera	-2.085068	30.054798
147	Hakizimana J.Pierre	783518472	Bugesera	-2.101382	30.058587
148	Nyirandorimana Cloudine	722026545	Gisagara	-2.635894	29.868034
149	Kwizera Eric	782554186	Gicumbi	-1.682893	30.140632
150	Umuhire Alex	787444948	Muhanga	-2.083851	29.755038
151	Mumararungu Yvonne	785983237	Nyamagabe	-2.456575	29.599110
152	Rwagasana Noel	725610112	Nyamagabe	-2.435555	29.601957
153	Niyoyita Ezechiel	782164012	Nyamagabe	-2.438465	29.597535
154	Uwihoreye Justine	785632558	Nyamagabe	-2.471745	29.589320
155	Kamana Kariste	722202650	Gisagara	-2.493661	29.907002
156	Mukaruranga Esperance	782120508	Rusizi	-2.601367	29.012633
157	Nyirangirimana Elianne	786567024	Rusizi	-2.603162	29.011720
158	Nyirandorimana Sophie	726846163	Gicumbi	-1.676533	30.132535
159	Mukangendo Clautilde	787043807	Gicumbi	-1.639013	30.116077

160	Isabane Shadrack	789773129	Gasabo	-1.929117	30.175423
161	Alex	788264012	Gasabo	-1.933837	30.173776
162	Nishimwe Nzayisenga Peter	788413597	Gasabo	-1.924237	30.175579
163	Ikizemwabo Aloys	784633450	Gasabo	-1.920667	30.172715
164	Dusengumuremyi Fabrice	783377044	Gasabo	-1.919670	30.171579
165	Nshimiyimana Francois	722515047	Gasabo	-1.921382	30.174155
166	Jean Bosco Kubwimana	788414053	Gasabo	-1.916651	30.177114
167	Kubwimana Jean Bosco	788414053	Gasabo	-1.927910	30.175694
168	Nshimiyemungu Jean Claude	788565976	Rusizi	-2.600867	29.012547
169	Nyiranzeyimana Marie	789843202	Rusizi	-2.600158	29.011897
170	Hakorimana Alphonse	725608275	Rulindo	-1.638935	30.022568
171	Alexandre Nkundimana	788881147	Rulindo	-1.628291	30.030372
172	Mporwiki Eugene	788516864	Rulindo	-1.698165	29.905848
173	Uwamarika Louise	782059421	Rulindo	-1.698513	29.907199
174	Hategekimana Ildephonse	788593117	Rulindo	-1.699711	29.906036
175	Uwizeyimana Patrick	726063722	Rulindo	-1.699801	29.906497
176	Ndayishimiye Servelien	788841446	Rulindo	-1.699756	29.906439
177	Ahishakiye	783964792	Rulindo	-1.686888	29.901794
178	Ineza Shingiro Thierry	785144770	Rulindo	-1.662870	29.887002
179	Omboni Olivier	784319094	Rubavu	-1.687202	29.295313
180	Charles Rybayiza	788689793	Rubavu	-1.684728	29.297982
181	Nsengiyunva Laurent	788470558	Rubavu	-1.685318	29.296527
182	Ndahiriwe Innocent	787375215	Rubavu	-1.684400	29.297030
183	Muntunundi Sebastien	788260203	Nyamasheke	-2.498383	29.033990
184	Ndaribumbye Rominathe	724749096	Nyamasheke	-2.507365	29.033830
185	Mukamusoni Marie Claire	788802880	Nyamasheke	-2.523122	29.024808
186	Mukandanga Febronie	783120830	Nyamasheke	-2.524353	29.021398
187	Adrienne Mukamugenzi	788422569	Nyamasheke	-2.519052	29.031400
188	Iribagiza Mediatrice	725741382	Nyamasheke	-2.518495	29.033540
189	Mukacyubahiro Anne Marie	788440888	Nyamasheke	-2.517965	29.033867
190	Mukakarima Beatrice	785218886	Nyamasheke	-2.507088	29.033462
191	Niyomuhoza Nehemie	782477884	Rusizi	-2.472407	28.919647
192	Theobard Ngizwenayo	788523454	Rusizi	-2.463733	28.925093
193	Hakizimana Francois	788533027	Gisagara	-2.679351	29.759806
194	Karuhije Theophile	788775882	Rusizi	-2.463853	28.923185
195	Bakundukize Jbatiste	785346038	Gisagara	-2.702122	29.749123
196	Mbarubukye Jean Leon	785235666	Rusizi	-2.469130	28.918910
197	Nayihiki Honorine	722020171	Rusizi	-2.593772	29.009600
198	Sr Raphaël Marie	786616859	Gisagara	-2.705624	29.744350
199	Musanganire Innocent	722060799	Rusizi	-2.596812	29.008665
200	Ndababonye Pascal	784827033	Gisagara	-2.705624	29.744350

201	Habumugisha Eliphaz	783625683	Nyamagabe	-2.434492	29.621358
202	Uwamariya Francine	789015644	Nyamagabe	-2.442435	29.610575
203	Akimana Charles	788888888	Nyamagabe	-2.450110	29.617738
204	Nyirahabimana Marie Goreth	727779347	Nyamagabe	-2.466268	29.619998
205	Uwimana Jean Marie	726812546	Nyamagabe	-2.468118	29.616433
206	Nzabamwita Agatha	784580517	Gisagara	-2.679351	29.759806
207	Byiringiro Fidel	788817940	Rwamagana	-1.962005	30.452252
208	Turinamungu Kayitani	788797785	Rwamagana	-1.961195	30.452127
209	Mukamugema Brandine	727052905	Rwamagana	-1.961170	30.451873
210	Rusanganwa Eugene	788569522	Rwamagana	-1.962387	30.456772
211	Nteziryayo Sylvan	782705990	Rwamagana	-1.968717	30.455763
212	Rukundo Eric	782705990	Rwamagana	-1.966818	30.455542
213	Bitwayiki Theodomile	789756569	Rwamagana	-1.967100	30.460625
214	Ndikubwimana Pascal	783502829	Rwamagana	-1.968080	30.465280
215	Niyonzima Jonas	727331505	Rusizi	-2.595738	29.009023
216	Nzeyimana Patrice	782575694	Rusizi	-2.596102	29.008328
217	Dusabimama Ildfonse	724240053	Rwamagana	-1.979385	30.236500
218	Nyirahakizimana Rachel	789276524	Rwamagana	-1.983278	30.239957
219	Uwimanikunze Eugenie	783470306	Rwamagana	-1.984693	30.239252
220	Dusabimana Vestine	786588020	Rwamagana	-1.985159	30.237531
221	Nkurunziza Emmamuel	782543066	Rwamagana	-1.990143	30.236545
222	Kandenzi Beata	784220463	Rwamagana	-1.978639	30.238650
223	Mukamana Alexia	786233522	Rwamagana	-1.977982	30.242459
224	Musabyimana Vestine	787228720	Rwamagana	-1.977157	30.243817
225	Ahobantegeye Odette	781288376	Rwamagana	-1.977625	30.241329
226	Nidufashe Alexis	785523127	Rwamagana	-1.976531	30.240046
227	Bizimana Calyxe	788927503	Rubavu	-1.687377	29.294240
228	Niyonkuru Igor	785728548	Rubavu	-1.690848	29.288593
229	Rukundo JMV	785626428	Rubavu	-1.686305	29.290053
230	Dusabimana Esther	789013535	Rubavu	-1.690457	29.289425
231	Tuyisenge Florida	782834469	Rubavu	-1.686428	29.293023
232	Theoneste Tuyisenge	788809947	Rubavu	-1.689447	29.294965
233	Harelimana J.Christome	788619449	Rulindo	-1.674387	29.895778
234	Deogratias Munyabaranga	788445723	Rulindo	-1.853784	29.971763
235	Bamurange Francine	783693540	Rulindo	-1.851800	29.972863
236	Mukamurigo Ansira	784504579	Rulindo	-1.852636	29.971582
237	Ntakirutima Alex	783005640	Rulindo	-1.852521	29.971829
238	Mukansengimana bertilde	780027993	Rulindo	-1.853067	29.971155
239	Mvukiyehe Daniel	784055470	Rulindo	-1.628103	30.030094
240	Ahishakiye Agnes	727009464	Nyamasheke	-2.384145	29.084668
241	Hagumubuzima Jonathan	783154884	Nyamasheke	-2.420095	29.066062

242	Hategekimana Anthere	788520720	Nyamasheke	-2.417260	29.068538
243	Mukatuyisenge Solange	783682613	Nyamasheke	-2.414482	29.072682
244	Mukabyiringiro Deborah	786407109	Nyamasheke	-2.427038	29.058885
245	Ayirwanda Stephanie	786758718	Nyamasheke	-2.430408	29.056518
246	Simparingabo Anaclet	788916031	Nyamasheke	-2.382723	29.083790
247	Sr Ingabire Venantie	781514711	Gisagara	-2.667990	29.824786
248	Imugane Syvestre	785069508	Gicumbi	-1.515618	30.044000
249	Umunezero Jeannette	782351317	Gicumbi	-1.517297	30.050068
250	Twahirwa Christophe	785759905	Gisagara	-2.667990	29.824786
251	Dusingizumukiza Emmanuel	783588539	Gicumbi	-1.517908	30.048558
252	Sindiheba Jean De Dieu	725907113	Gicumbi	-1.517650	30.055442
253	Uwihanganye Clarissa	787078366	Gisagara	-2.667990	29.824786
254	Mukandekazi Madelena	731822478	Gisagara	-2.667990	29.824786
255	Gakwaya John	786525553	Gisagara	-2.667990	29.824786
256	Umutesi Editha	726525483	Nyamasheke	-2.526503	29.022297
257	Musabyemariya Peruth	789599716	Nyamasheke	-2.424452	29.070885
258	Nsengumuremyi Pierre	785584899	Nyamasheke	-2.419918	29.067945
259	Uzagisenga Ernestine	786759987	Nyamasheke	-2.519620	29.031002
260	Munyemana Donatien	788730510	Nyamasheke	-2.382543	29.083770
261	Ndayisabye Ndera Erneste	788530193	Nyamasheke	-2.381393	29.084408
262	Bayavuge Anastase	783129809	Gicumbi	-1.518950	30.057565
263	Zirimwabagabo Vincent	727813135	Gicumbi	-1.526498	30.068062
264	Nkundabera Pierre	781400306	Rwamagana	-1.951780	30.448522
265	Nsengiyumva Tharicisse	788494220	Rwamagana	-1.952548	30.448685
266	Murekatete Edith (Murekatete Edith. Club Coordinator)	788677444	Rwamagana	-1.951188	30.448635
267	Cooperative Irengo Ry'ubukire	788623638	Rwamagana	-1.938617	30.456412
268	Mpayimana Celestin	727900991	Rwamagana	-1.934030	30.446593
269	Dusenge Manasseh	781119119	Rwamagana	-1.942468	30.455598
270	Habumugisha Leonce	788409207	Rwamagana	-1.935308	30.446225
271	Serugenda Emilien	783618150	Gicumbi	-1.515693	30.057170
272	Safari Dieudonné	783790586	Gicumbi	-1.507567	30.057062
273	Hitimana Joseph	780170383	Gicumbi	-1.516547	30.049665
274	Ntibihezwa	786334748	Nyamagabe	-2.435287	29.429072
275	Nzeyimana Venuste	788422868	Nyamagabe	-2.434735	29.435005
276	Ngabonziza Manasseh	780078444	Nyamagabe	-2.432605	29.430212
277	Musabyimana Esperance	787386546	Nyamagabe	-2.432145	29.429433
278	Dushimimana Marie Rose	788792776	Nyamagabe	-2.431010	29.428793
279	Ruberankiko Anastase	780433534	Nyamagabe	-2.430685	29.436450
280	Ndayambaje Dismas	723356586	Nyamagabe	-2.421567	29.437060
281	Nyirandimubanzi Epephanie	725495650	Nyamagabe	-2.438085	29.428477
282	Mpatsinkima Fidel	722236100	Nyamagabe	-2.433065	29.442105

283	Ndikumana Ezekiel	722999613	Nyamagabe	-2.429158	29.434360
284	Mupenzi Justin	783662461	Gicumbi	-1.518363	30.045237
285	Gahundi Damas	783997277	Gasabo	-1.848711	30.198986
286	Karangwa Patrick	724131761	Gasabo	-1.848672	30.197729
287	Twagirimana Leopord	786000715	Gasabo	-1.852053	30.207770
288	Rwandenzi Jerve	788877356	Gasabo	-1.847027	30.210427
289	Tuyishimire Nadine	722628147	Gasabo	-1.857187	30.198024
290	Kifuzo Jean Aime	785893185	Gasabo	-1.857649	30.193448
291	Niyongombwa Ferdinand	788735516	Gasabo	-1.853820	30.204058
292	Musabyimana Angelique	728783426	Gasabo	-1.853652	30.201951
293	Mukaniyonsenga Donata	726259127	Gasabo	-1.860381	30.194144
294	Fils Randourd	783158730	Gasabo	-1.855460	30.196714
295	Nsengiyumva Narcisse	788798077	Muhanga	-2.089311	29.760310
296	Tuyisenge Feliste	783756683	Muhanga	-2.089311	29.760310
297	Uwimana Nadine	789535028	Muhanga	-2.073092	29.783253
298	Tuyisenge Jean Claude	783414153	Gicumbi	-1.616852	30.086890
299	Ndizihiwe J.Francois Legis	780607616	Muhanga	-2.073092	29.783253
300	Uwamahoro Francoise	785241811	Muhanga	-2.078374	29.789882
301	Niyigaba Sylve	788548381	Muhanga	-2.087591	29.765221
302	Sibomana Viateur	781552552	Muhanga	-2.078688	29.763174
303	Yankurije Vestine	789651170	Rwamagana	-1.974387	30.235149
304	Kwizera Pacifique	780950050	Rwamagana	-1.970022	30.233826
305	Ngabonziza Emmanuel	784856743	Rwamagana	-1.974527	30.246668
306	Uwamariya Julienne	782050939	Rwamagana	-1.979220	30.249170
307	Emmanuel Harerimana	788426538	Rwamagana	-1.992481	30.247067
308	Ayinkamiye Bernadette	782317742	Muhanga	-2.077282	29.738245
309	Uwimanirebera Bernadette	728532199	Muhanga	-2.092125	29.731975
310	Igirimpuhwe Lucia	781138813	Muhanga	-2.071422	29.758623
311	Ndahiro Patrick	785688560	Muhanga	-2.086425	29.731015
312	Zaninka Leonie	785426856	Muhanga	-2.077582	29.744670
313	Habinshuti Elyse	785642335	Muhanga	-2.076528	29.744317
314	Gasangwa Renduard	724582018	Muhanga	-2.074717	29.739507
315	Uwizera Claver	785423855	Muhanga	-2.083243	29.748937
316	Mpakaniye Emmanuel	788480480	Muhanga	-2.079807	29.750665
317	Dufatanye Viateur	734635455	Muhanga	-2.077877	29.751803
318	Karinijabo Émaille	788873793	Muhanga	-2.074012	29.780846
319	Musonera Jean	782553936	Muhanga	-2.074012	29.780846
320	Nsengimana Prosper	788557814	Muhanga	-2.074012	29.780846
321	Safari Emmanuel	723531120	Muhanga	-2.074012	29.780846
322	Tuyizere Innocent	780072166	Muhanga	-2.074012	29.780846
323	Karinijabo Vedaste	788886593	Muhanga	-2.079090	29.745393

324	Mutangana Porfile	785236552	Muhanga	-2.083637	29.742267
325	Ndagijimana Vincent	722351823	Muhanga	-2.080948	29.750352
326	Kubwimana Philippe	732515689	Muhanga	-2.080097	29.750390
327	Akimana Aphrodis	782323521	Muhanga	-2.075558	29.762072
328	Uwihoreye Maurice	785632561	Muhanga	-2.080082	29.764808
329	Mutuyimana Mari	783465557	Muhanga	-2.074012	29.780846
330	Nyarasafari Elizabeth	785869986	Muhanga	-2.074012	29.780846
331	Giramata Rosine	784559430	Muhanga	-2.074012	29.780846
332	Sekamondo Isaie	785685854	Nyamagabe	-2.513698	29.481053

**APPENDIX IV: LIST OF PORK TRADERS INTERVIEWED (BUTCHERIES, BARS, SUPERMARKETS AND RESTAURANTS)**

<b>Sn</b>	<b>Names</b>	<b>Location/District</b>	<b>Phone Number</b>
1	Yirirwahandi J.M.V	Gisagara	0783538733
2	Mutabaruka Jean Damascene	Gisagara	0785007867
3	Hanganimana Steven	Gisagara	0787558574
4	Nkunsi Bernard	Gasabo	0788862631
5	Bizimana Alphonse	Rubavu	0783125276
6	Mutandura Innocent	Rubavu	0788754379
7	Rushema Janvier	Rubavu	0788589867
8	Musonera Didier	Rubavu	0785453897
9	Nzabahimana Emmanuel	Rubavu	0782564780
10	Hakuzimana Binifas	Rubavu	0783408808
11	Ntakabuza J.D	Rubavu	0783094146
12	Hafashimana Justin	Rubavu	0788212094
13	Ndayambaje Fulgence	Nyagatare	0788343106
14	Umulisa Beatrice	Nyagatare	0788521561
15	Nsekarije Antoine	Nyagatare	0788880141
16	Dusabe Louise	Nyagatare	0786944756
17	Numviyimana Leonidas	Nyagatare	0783359530
18	Mugura Stanislas	Nyagatare	0788731284
19	Nshimiye Appolon	Nyagatare	0782490757
20	Mugisha Jean Bosco	Gasabo	0784266545
21	Nsanzamahoro Hassan	Gasabo	0786285257
21	Uwamahoro Michel	Gasabo	0782161477

#### APPENDIX V: LIST OF CONSUMERS INTERVIEWED

No	NAMES	DISTRICT	SECTOR	TEL
1	Uwizeyimana Jean De Dieu	Gasabo	Gatsata	0784646107
2	Irudukunda Kevin	Nyarugenge	Nyarugenge	0786687882
3	Karuranga Alex	Nyarugenge	Nyarugenge	0788250948
4	Mutesi Alphonsine	Gasabo	Kimironko	0787699345
5	Ntamuhanga John	Gasabo	Remera	0788933065
6	Muhawenimana Marie	Gasabo	Gatsata	0788997095
7	Mutamba Oliver	Nyarugenge	Nyarugenge	0781057305
8	Mutsinzi Laurent	Gasabo	Remera	0786128139
9	Nyiragikwiye Fortune	Gasabo	Kacyiru	0788683313
10	Shyaka Innocent	Gasabo	Gatsata	0788695746
11	Uwizeyimana Valentine	Musanze	Muhoza	0788573523
12	Hagumineza Alexis	Burera	Nemba	0785312222
13	Havugineza Modeste	Musanze	Muhoza	0788779675
14	Nyirazaninka Joseline	Musanze	Muhoza	0783580582
15	Umutoniwase Opurence	Musanze	Muhoza	0789510672
16	Nkerabigwi Placide	Musanze	Rwambogo	0788872863
17	Ingabire Yvonne	Musanze	Cyuve	0788621192
18	Mutabaruka Jean Damascene	Gisagara	Mugombwa	0785007867
19	Biziyaremye Jean De Dieu	Gisagara	Mugombwa	0736363947
20	Nsekanabandi Jean Baptiste	Gisagara	Mugombwa	0789012106
21	Nyirabajyiwabo Marie Agnes	Gisagara	Mugombwa	0786994199
22	Ntahidakiriza Janvier	Gisagara	Mugombwa	0784258987
23	Niyonkuru Eric	Gisagara	Mugombwa	0787616896
24	Kayitesi Mercienne	Gisagara	Mugombwa	0786815923
25	Nduwamungu Epiphanie	Gisagara	Mugombwa	0782159141
26	Habineza Eric	Gisagara	Mugombwa	0786202471
27	Usabyimana Patrice	Gisagara	Mukura	0722344995
28	Bashakimana Theophile	Huye	Ngoma	0780690407
29	Ntakirutimana Lucky	Huye	Ngoma	0788518743
30	Niyonkuru Phocas	Huye	Ngoma	0788472872
31	Niyokwizerwa Didier	Huye	Ngoma	0788480386
32	Hashakimana Philemon	Huye	Ngoma	0788336670
33	Bisimwa Biharirwa Thimothee	Huye	Matyazo	0786126892

34	Uwera Joselyne	Gisagara	Mugombwa	0780165592
35	Mukakalisa Leocadie	Gisagara	Mugombwa	0783782706
36	Mutuyimana Michel	Gisagara	Mugombwa	0786265477
37	Baryazahe Diome	Nyagatare	Tabagwe	0788800299
38	Mutabaruka Alexandre	Nyagatare	Tabagwe	0789754966
39	Mukeshimana Poline	Nyagatare	Tabagwe	0783973834
40	Ndizeye Noah	Nyagatare	Rwempasha	0780542959
41	Hakizamungu Gibert	Nyagatare	Nyagatare	0788791264
42	Nsekanabo Landuard	Nyagatare	Rwempasha	0788735028
43	Twahirwa Theoneste	Nyagatare	Nyagatare	0788676693
44	Ndayambaje Fulgence	Nyagatare	Nyagatare	0788343106
45	Umulisa Beatrice	Nyagatare	Nyagatare	0788521561
46	Dusabe Louise	Nyagatare	Nyagatare	0786944756
47	Niyonzima Alfred	Nyagatare	Nyagatare	0782614962
48	Rukundo Alex	Nyagatare	Nyagatare	0781001505
49	Ndacyayisenga Papias	Nyagatare	Rukomo	0783862110
50	Harerimana Manas	Nyagatare	Tabagwe	0788580964
51	Akimanimaye Vestine	Nyagatare	Tabagwe	0781491462
52	Pendo Simon	Rubavu	Gisenyi	0782725831
53	Ngarambe Jackson	Rubavu	Gisenyi	0788349663
54	Uwizeye Answer	Rubavu	Gisenyi	0783164056
55	Twizerimana Jacques	Rubavu	Gisenyi	0784741346
56	Dusabimana Valence	Rubavu	Gisenyi	0785766527
57	Nzanzimana Emmanuel	Rubavu	Gisenyi	0785233914
58	Uwizeye Lydia	Rubavu	Gisenyi	0785668106
59	Karenzi Eric	Rubavu	Gisenyi	0785565907
60	Musoni Fred	Rubavu	Gisenyi	0780753340
61	Nsengiyunva Stephen	Rubavu	Gisenyi	0787226919
62	Iraguha Blaise	Musanze	Muhoza	0788504568
63	Hakizimana Jean d'Amour	Kicukiro	Niboye	0788883348

## APPENDIX VI: RESPONSES TO COMMENTS FROM RAB, ENABEL AND NIRDA

<b>Comment</b>	<b>Response</b>
Executive summary is not very informative, it is lacking recent data to support key findings, recommendations	<i>Changes effected- Page (i)</i>
General introduction refers to old information with no reference for eg agriculture GDP contribution, poverty reduction data of 2011; no reference to the LMP projections; PSTA4	<i>Changes effected- page 1</i>
-Projection of pig population and products -Accurate market data, especially domestic demand, import and export	<i>Section 2.2.1 (pg 15)</i> <i>Section 2.2.3 (pg 17)</i> <i>Section 2.4.1 (pg 21)</i>
Pig value chain presented in figure 2 does not include enabling environment actors like extension, legal framework, policy	<i>Section 2.3 (pg 18)</i>
ASF is also not common in neighboring countries as mentioned	<i>Is reported in several studies in Uganda</i>
Comparison with the region/international stage is also missing	<i>Section 2.2.2 (pg 16)</i> <i>Section 2.4.2 (pg 21)</i>
Technological gaps, issues and challenges found in the VC which was the main objective of this technology audit	<i>Chapter 6 (pg 106)</i>
Components on the value chain map like processing which falls in the technology audit	<i>Section 3.4 (pg 39 – 43)</i>
Business advisory support	<i>Section 5.9.3.(pg 125)</i>
Justification to NIRDA to intervene with technology support	<i>Section 5.9.1 (pg 124)</i>
The eligibility criteria should be reviewed	<i>Chapter 8 (pg 141 – 144) reviewed</i>
Employment opportunities in all key components of the piggery VC	<i>Section 5.6.3.(pg 113)</i> <i>Section 6.4 (pg 118)</i>
Income of smallholder farmers	<i>Table 25 (pg 101)</i>
How women and youth involvement can be promoted,	<i>Section 5.4.5.(pg106)</i>
Proposed recommendations for upgrade	<i>Chapter 6</i>
optimization of the VC for eg: proposed actions to improve operations	<i>Chapter 6</i>
Matrix showing technological/technical gaps and their interventions.	<i>Table 33, (pg136)</i>
Proposed interventions for upgrading and optimising technology at	<i>Section 5.4.7 (pg112)</i>

slaughter and processing	
Slaughterhouses design and requirements	<i>Pg112 – 114</i>
Consumption technologies,	<i>Section 5.4.8 (pg 110)</i>
Proposal for diseases management	<i>Section 5.7.1 (pg117)</i>
SWOT analysis	<i>Section 2.7 (pg 25)</i>
The pig AI inseminators trained by RAB from 2014 to 2019 are 83.	<i>Section 5.1.2 (pg 86)</i>
Centers of Excellence for pig breeder	<i>Section 5.4.3 (pg 104)</i>
Private sector contribution in technology dissemination	<i>Section 5.2.1(pg 93)</i>
Breeding policy for all livestock	<i>Section 7.2.3.(3) pg 116</i>
Rwanda FDA registration for the processors to be included in the final report	<i>Section 8.2.3 (page 167)</i>
Recommendations are too broad, need to rewrite them in actionable recommendations for a better understanding and implementation for NIRDA	<i>Chapter Seven has been re-written (page 137 – 143)</i>
The proposed technologies should be highlighted in the executive summary, for each segment of the piggery value chain, to facilitate users of this document.	<i>The section has been revised and details added (page i – ix)</i>
Define production systems as presented in the results section to match with our current findings	<i>Section 2.2.1 introduced (page 16)</i>
Private AI services should be promoted.	<i>Section 5.5.2 (pg111)</i>
Estrus synchronisation	<i>Section 5.3.4 (105)</i>
Pig semen and distribute it using the guided drones	<i>Section 5.1.9 (pg 92)</i>
Functional literacy programs	<i>Section 5.7.3.(iii) (pg 120)</i>
Standards and designs for animal/pig slaughterhouses	<i>Section 5.7.2.(ii) pg 118</i>
Law enforcement to control illegal back yard slaughtering	<i>Section 7.1 (pg137)</i>
Veterinary services	<i>Section 5.7.1 (pg 117)</i>
Feed formulation for smallholder farmers	<i>Section 5.7.2 (iv) pg 118</i>
Web-based GIS embedded digital identification and traceability system	<i>Section 5.3 (pg 93)</i>
Livestock insurance	<i>Section 5.7.2 (pg 118)</i> <i>Section 5.9.3 (pg 124)</i>
Financial products could include financial product that encourage the private sector to invest in the commercialization of pig products	<i>Section 6.2.3 (pg 127)</i>
Piggery business hubs	<i>Section 5.4.4 (pg 105)</i> <i>Section 7.2.1 (1) pg138</i>

Differentiation between the public goods and private goods	<i>Section 5.5.3 (pg112)</i>
To enhance the level of participation of women in the value chain,	<i>Section 5.4.4 (pg 105)</i>
Distribution of Large White, Landrace, Pietrain and local breeds	<i>Section 5.1.2 (pg 84-88)</i>
Farming practices specialization	<i>Section 5.4.2 (pg 103)</i> <i>Section 5.4.3 (pg 104)</i>
Recommendations for people who want/ or investors in the VC	
New technology NIRDA can bring, gaps in industrial skills.	<i>Section 5.9.2 (pg 123)</i>
Business development support	<i>Section 5.9.3 (pg124)</i>
Characterize the productions systems	<i>Section 5.1.1 (pg 81-83)</i>
Technology in pig feed production	<i>Section 5.5.2 (pg111)</i> <i>Section 5.9.2 (pg 123)</i>
Technology in Animal recording	<i>Section 5.1.4 (pg 88)</i> <i>Section 5.9.2 (pg 123)</i>
Names and telephone numbers	<i>Appendices I-V (pg 145-160)</i>