Food and Agriculture Organization of the United Nations

National Agricultural Innovation System Assessment in Rwanda

Report on the small livestock sub-sector

May 2022

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Foreword

Rwanda's ambition is to become a knowledge-based middle-income economy by 2035 with agriculture as backbone for sustained economic growth. This agenda aims at having a nation that enjoys food security, nutritional health, and sustainable agricultural growth from a productive, green and market-led agriculture sector. Therefore, agricultural innovation becomes a necessity in order to realize this very ambitious agenda. The focus is to improve agronomic knowledge and technologies in terms of applied research and innovations, development of good extension services as well as knowledge and information along the value chains. The Agricultural Innovation System (AIS) is a process where individuals or organizations bring existing or new products, processes and forms of organization into social and economic use to increase effectiveness, competitiveness, resilience to natural shocks or environmental sustainability, thereby contributing to food and nutritional security, economic development and sustainable natural resource management.

The AIS was therefore assessed by FAO-Rwanda, with a focus on the small livestock sub-sector. This was done to take stock of AIS and provide insights on factors that influence the capacity to enable foster and promote inclusive and responsible innovations, identifying critical gaps, needs, opportunities as well as good practices. The AIS Assessment in Rwanda is one of the key deliverables of the project "Developing capacities in agricultural innovation systems: scaling up the Tropical Agriculture Platform (TAP) Framework", supported by the European Union (EU).

The AIS assessment in the small livestock sub-sector of Rwanda benefitted a great contribution from agriculture stakeholders namely: rural farmers, private sector, civil society, development partners, government institutions, Rwanda Agriculture and Animal Resources Development Board (RAB), and representatives from the Ministry of Agriculture and Animal Resources (MINAGRI) and various experts in the agricultural innovation sector among others. In this AIS assessment, the enabling environment as well as the systemic capacity gaps were assessed. This helped in tailoring recommendations and key actions to be undertaken in order to boost the small livestock sub-sector. I would like to reiterate that the results from this AIS assessment in the small livestock sub-sector of Rwanda report will unreservedly guide the strengthening of capacities for innovation in the small livestock sub-sector, with focus on organizations and the policy level.

Conclusively, I express my sincere thanks to the support received from key stakeholders and Partners, and I wish an ever-lasting collaboration at all levels to continue moving towards the sustainable agricultural innovations in Rwanda.

Otto Vianney Muhinda
Assistant FAO Representative/Programme

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We would like to express our gratitude to the Government of Rwanda, the Food and Agriculture Organization of the United Nations (FAO) representation in Rwanda, the FAO's Research and Extension Unity, Office of Innovation (OINR), the project Country Advisory Team, for the support provided throughout the assessment.

We would also like to thank the Institute of Policy Analysis and Research (IPAR-Rwanda) for having conducted the AIS assessment promptly. In a similar way, special thanks and appreciations are extended to Dr. Jean Baptiste Nsengiyumva for having led the AIS assessment process up to its completion.

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The AIS Assessment benefited from the inputs of different stakeholders. FAO extends its appreciation to all participants in the study including the smallholder farmers, experts from various institutions who provided information during data collection especially the capacity gap analysis (CGA). Representatives of a range of organizations, including but not limited to the Rwanda Agriculture and Animal Resources Development Board (RAB), Uzima Chicken Limited, Gorilla Feeds Industry, "Centre de Perfectionnement et de la Promotion Agricole (CPPA Kisaro)", Vision Agribusiness Farm Limited (VAF), the Rwanda Pig Farmers Association (RPFA), the Rwanda Poultry Industry Association (RPIA), NGOs among others. Additionally, special thanks to other key stakeholders for their collaboration, support, views and insights throughout the entire process.

A special recognition goes to the European Union (EU), through its initiative "Development of Smart Innovation through Research in Agriculture (DeSIRA): Towards climate-relevant Agriculture and Knowledge Innovation Systems", for the financial support provided.

List of acronyms

AgSWG	Agricultural Sector Working Group
AIS	Agricultural Innovation Systems
AU	African Union
BRD	Rwanda Development Bank
CAHW	Community Animal Health Workers
CGA	Capacity Gap Analysis
CGIAR	Consortium of International Agricultural Research Centers
CIRAD	Centre de Coopération Internationale en Recherche Agronomique Pour le Développement
CPPA	Centre de Perfectionnement et de Promotion Agricole
CSOs	Civil Society Organisations
DAROs	District Animal Ressources Officiers
DDG	Deputy Director General
EAC	East African Community
ERF	Economic Recovery Fund
FAO	The Food and Agriculture Organization of the United Nations
FBOs	Faith-based Organizations
FGDs	Focus Group Discussions
FIs	Financial institutions
GDP	Gross Domestic Product
HLIs	Higher Learning Institutions
INES	Institut d'Enseignement Supérieur de Ruhengeri
INGOs	International Non-Government Organizations
IPAR	Institute of Policy Analysis and Research-Rwanda
KIIs	Key Informant Interviews
LFFS	Livestock Farmer Field School Facilitators
LNGOs	Local Non-Government Organizations
MINAGRI	Ministry of Agriculture and Animal Resources
MINALOC	Ministry of Local Government
MINECOFIN	Ministry of Finance and Economic Planning
MINICOM	Ministry of Commerce, Trade and Industry
MININFRA	Ministry of Infrastructure
MOE	Ministry of Environment
NGOS	Non-Government Organisations
NIRDA	The National Industrial Research and Development Agency
NISR	National Institute of Statistics of Rwanda
NPC	National Project Coordinator
NST1	National Strategy for Transformation one
NVVH	New vision Veterinary Hospital
OIN	Office for Innovation
POs	Private Operators
PSF	Private Sector Federation Rwanda
RAB	Rwanda Agriculture and Animal Resources Development Board

RARICO	Rwanda Animal Resources Improvement Cooperative
RASO	Rwanda Animal Scientists Organisation
RCA	Rwanda Cooperative Agency
RCAL	Rwanda Chamber of Agriculture and Livestock (PSF/
RCVD	Rwanda Council of Veterinary Doctors
RDB	Rwanda Development Board
RICA	Rwanda Institute for Conservation Agriculture
RIS	Research Institutions
R-LPM	The Rwanda Livestock Master Plan
RMA	Rwanda Meteorological Agency
RPFA	Rwanda Pig Farmers Association
RPIA	Rwanda Poultry Industry Associations
RVO	Rwandan Veterinary Organisation
SACCO	Savings and Credit Cooperative Organization
SAROs	Sector Animal Resources Officers
SEAD	Strengthening Education for Agricultural Development
SNV	Stichting Nederlandse Vrijwilligers (Netherlands Development Organization)
SPIU	Single Project Implementation Unit
SWOT	Strengths, Weaknesses, Opportunities and Threats
TAP	Tropical Agriculture Platform
UNILAK	University of Lay Adventists of Kigali
UR	University of Rwanda
VAF	Vision Agribusiness Farm Limited
VHS	Veterinary Health Sector
Y&W	Youth and Women
YEAN	Youth Engagement in Agriculture Network

Executive summary

Rwanda is on a transformation path from a low-income to a middle-income economy and to achieve this the government of Rwanda has prioritized transformation of the agricultural sector as it remains the backbone for sustained economic growth. Central to this path, improving the living standard of the population and the quality of livelihoods is key. Given the conducive agro-ecological conditions that enable intensified livestock production, the small livestock sub-sector provides promising opportunities for increased contribution to economic growth and improved income to reduce poverty and improve nutritional security of many small rural farming households.

Although the small livestock sub-sector in Rwanda has contributed to the economic development, the sub-sector is still constrained by challenges such as local breeds with low productivity, and high morbidity and mortality rates in small livestock. As result, agricultural innovation needs to be embraced to boost the small livestock sub-sector, increase its contribution to the country's economic growth and help achieve the country's vision to become a nation that enjoys food security, nutritional health and sustainable agricultural growth from a productive, green and market-led agricultural sector.

The TAP-AIS project "Developing capacities in agricultural innovation systems: scaling up the Tropical Agriculture Platform (TAP) Framework", one of several global, regional and national projects under EU's DeSIRA initiative, aims at enhancing and accelerating innovation for agriculture and rural transformation while putting emphasis on climate-relevant actions. Under this project, the Institute of Policy Analysis and Research (IPAR-Rwanda) was commissioned by FAO-Rwanda to carry out an assessment of the Agriculture Innovation System (AIS) in the small livestock sub-sector in Rwanda.

The expected outputs of the assessment were: A description of the AIS of the small livestock sub-sector in Rwanda in terms of key functions, the underlying causes of their performance, and opportunities for improvement; suggested performance indicators to enable monitoring and evaluation of future support actions to the AIS; and clear recommendations, priorities and entry points for strengthening the AIS of the small livestock sub-sector in Rwanda, with focus on key organisations and the policy level.

The assessment focused on three cases studies of innovation in the small livestock sub-sector: The Sasso dual breed chicken by Uzima Chicken Limited, with focus on small-scale farmers' poultry production; piggery/artificial insemination by the Centre for Agriculture Enhancement (CPPA) in Kisaro, for genetic improvement in pigs for small-holder farming; and the animal feed industry by Gorilla Feed Co., Limited, a cross-cutting business with significant implications for animal production in livestock farming.

The AIS assessment was conducted using a qualitative approach with desk reviews, key informant interviews (KIIs) and Focus Group discussions (FGDs) in the city of Kigali and in Rwamagana, Bugesera, Rulindo and Gicumbi Districts, for the three case studies. The AIS

assessment combined structural analysis, functional analysis, capacity analysis and enabling environment analysis (enablers and disablers) as described in the FAO guidelines for AIS assessment. A systemic capacity gap analysis (CGA) identified gaps in the institutional and policy environment in the small livestock sub-sector and suggested ways for improvement. A total of 12 FGDs and 42 KIIs were conducted for the case studies. Twenty-two experts from various organizations in both public and private sectors participated in the systemic capacity gap analysis and provided views, thoughts and inputs.

From the key findings of the AIS assessment, it was noted that: i) There are capacity gaps in equipping farmers in the small livestock sub-sector with the understanding and knowledge that would enable them to perform effectively; ii) There is need to establish a capacity development scheme for small livestock farmers through equipment and skilled personnel in relation to detection of new diseases; iii) There are knowledge gaps among small-holder farmers regarding technical know-how on taking care of chicken and pigs; iv) There are gaps in business management skills and financial literacy among farmers; and (v) There are coordination gaps between different stakeholders involved in the small livestock sub-sector.

Based on the AIS Assessment findings, the following three organizations are recommended to be part of the TAP-AIS project's organizational capacity development:

- National platform on the small livestock in Rwanda
- Uzima Chicken Limited
- Centre de Perfectionnement et de la Promotion Agricole (CPPA Kisaro)

However, for systemic capacity development, two additional platforms were recommended by stakeholders during the AIS assessment validation workshop:

- Rwanda Pig Farmers Association (RPFA)
- Rwanda Poultry Industry Association (RPIA)

Based on the AIS assessment results and the related validation workshop that followed, the following are recommended:

Collaboration and coordination

1. **Empower and strengthen the national platforms on small livestock in Rwanda, specifically those dealing with pig and poultry value chains**. The responsibility for small livestock is fragmented across different organizations, creating coordination challenges. Platforms such as the national platform on small livestock in Rwanda, Rwanda Pig Farmers Association (RPFA) and Rwanda Poultry Industry Associations (RPIA) have been formed to provide such coordination, but needs to become more active. To realize this, there should be improvement in coordination, dialogue and interaction among key stakeholders about best practices to enhance agricultural innovations, to create linkages among all actors from both the public and private sectors who play a major role at different nodes in the networks.

Capacity development

2. **Ensure continuous learning and improvement** of actor's knowledge, soft skills and practices for marketing and networking capacities.
3. **The Government of Rwanda through MINAGRI should mainstream soft skills** in all its strategic plans to guarantee the sustainability of innovations in the small livestock sub-sector.
4. **Advisory services should put more efforts into strengthening capacities of farmers and cooperatives** in small livestock management and related business skills.

Policy

5. **Mainstreaming of agricultural innovation across all policies, strategies and programmes** that promote the small livestock sub-sector, especially animal health and veterinary services, animal feeds and transport facilities for live animals and meat.
6. **Strengthening funding mechanisms that support smallholder farmers' access to affordable finance** particularly those living in remote rural areas to create a conducive working environment for vulnerable people.
7. **Enhancing and promoting investment in research and development** to support innovations in the small livestock sub-sector.
8. **Government and financial institutions through farmers' associations should improve farmers' access to agricultural insurance** to reduce agricultural risks. This should also involve education and community awareness creation.
9. **The Government of Rwanda through MINAGRI should put in place a strong monitoring framework** to follow up on the implementation of the AIS recommendations for the small livestock sub-sector.

1. Introduction

The current report was produced by the Institute of Policy Analysis and Research (IPAR) from the agricultural innovation system (AIS) assessment within the small livestock sub-sector in Rwanda under the TAP AIS project 'Developing capacities in agricultural innovation systems: scaling up Tropical Agriculture Platform Framework'. The assessment focused on three cases studies identified as entry points within the small livestock sub-sector including the Sasso dual purpose breed by Uzima chicken with major focus on the small-scale farmers; piggery/artificial insemination by the Centre for Agriculture enhancement (CPPA) in Kisaro for genetics improvement; and the animal feed industry by Gorilla Feeds which serves as a cross-cutting issue whilst its results have significant implications for animal production in livestock farming.

The report therefore presents key findings and results from the analysis of the information collected in April 2021 using the qualitative approaches such as key informant interviews, focus group discussions with key actors and desk reviews. Based on the findings from the AIS Assessment, the Government of Rwanda, development partners and others actors will be in a better position to address the identified challenges and gaps. This will provide an opportunity to strengthen the small livestock sub-sector through capacity development for individuals and organizations to create an enabling environment, organizational capacity building and promotion of agricultural innovations for rural farmers to be able to do things differently.

The AIS assessment provides evidence-based results that inform policy and decision-makers on the strengths and opportunities in the small livestock sub-sector, and weaknesses and threats that inhibit the sub-sector to perform adequately. This will in turn help them to design appropriate solutions in terms of planning investments, develop innovation capacities at all levels, put in place innovation capacity and development strategies, improve the AIS, transformation of the small livestock sub-sector and ensure food security while reducing poverty.

2. Background

Agriculture and food systems are facing quite a number of challenges in many low and middle-income countries (Rajalahti et al., 2008). Assessments of agriculture innovation systems (AIS) capacities in low-income countries including Rwanda revealed major challenges including gaps in policies, limited investments and poor coordination among research and extension services, among others. In the framework to overcome these challenges, a Tropical Agriculture Platform (TAP), a G20 initiative to promote agricultural innovations in the tropics was formed in 2011 to identify and address capacity issues – in particular functional capacities (soft skills) – at individual, organizational, and policy levels. To this end, the TAP Common Framework on capacity development for agricultural innovation was developed and tested in eight pilot countries including Rwanda, through the project "Capacity Development for Agricultural Innovation Systems (CDAIS)"

The CDAIS project was implemented in Rwanda and seven other countries from 2015-2019 with funding from the European Union and jointly coordinated by the Food and Agriculture Organization of the United Nations (FAO) and Agrinatura. The project operated under the TAP, the main objective being to strengthen capacity to innovate in three key selected innovation partnerships. Due to the project, awareness was created with regard to the need to strengthen AIS in Rwanda. The lessons learnt informed the TAP action plan 2018-2021.

From 2019, the European Union's initiative "Development of Smart Innovation through Research in Agriculture (DeSIRA)" supports TAP through the project "Developing capacities in agricultural innovations systems: scaling up the Tropical Agriculture Platform framework" (TAP-AIS, for short). The project builds on lessons learnt from the CDAIS project, and is scaling up TAP Common Framework approach and tools at national and regional levels. The Project's expected outcome is "Strengthened capacity to innovate in national agricultural innovation systems". It is implemented in nine countries worldwide, including Rwanda, in close collaboration with national government partners, and regional and global partners.

To guide the design of the project's capacity development phase, which focuses on organizational, and policy and enabling environment levels, assessments of national agricultural innovations systems are carried out using a methodology developed by FAO. In Rwanda, consultations during the project's inception phase with key national stakeholders, government agencies and international organizations identified the small livestock sub-sector as the focus of the AIS assessment, a sub-sector considered a priority in the current Strategic Plan for Agriculture Transformation (PSTA4) and Rwanda's Livestock Master Plan.

The AIS assessment started in December 2020 with a series of trainings for the assessment team, followed by primary and secondary data collection, analysis and report writing during January to September 2021. Three cases within the small livestock sub-sector were assessed: (i) Poultry farming: the Sasso breed in Rwanda; (ii) Pig farming; and (iii) The animal feeds industry. Taken together, these provide a broad picture of how innovation processes in the small livestock sub-sector in Rwanda are functioning, how these could be improved and what actions the TAP-AIS project should take in its capacity development phase in 2021 and 2022 to strengthen national capacities to innovate. Findings from the AIS assessment are intended

to set priorities for capacity development interventions and recommend entry points for strengthening the AIS of the small livestock sub-sector in Rwanda.

3. Objectives and priorities

The general objective of the AIS assessment in Rwanda was to provide insights on the country's agricultural innovation systems with focus on the small livestock sub-sector, and identify critical gaps, needs and opportunities for improvement, as well as good practices.

Specifically, the objectives of the AIS assessment of the small livestock sub-sector were:

1. To describe the key functions in innovation processes and identify constraints and bottlenecks.
2. To identify the TAP-AIS project's niche within the AIS of the small livestock sub-sector and prioritize opportunities and entry points for the projects capacity development phase.
3. To enable the TAP-AIS project to make informed decisions on engagement with stakeholders, and allocation of limited resources, to add value to the small livestock sub-sector in Rwanda.

The AIS assessment was expected to deliver the following outputs:

1. A description of the AIS of the small livestock sub-sector in Rwanda in terms of the key functions, the underlying causes of their performance and opportunities for improvement.
2. Suggested indicators for measuring AIS performance to enable the monitoring and evaluation of future support actions to the AIS.
3. Clear recommendations, priorities and entry points for strengthening the AIS of the small livestock sub-sector in Rwanda with focus on key organizations and the policy level.

4. Agricultural innovation in the national context

4.1 National development context

Rwanda is located in the central-eastern Africa bordered by Uganda, Tanzania, Burundi and the Democratic Republic of Congo with a total area of 26,338 km^2. It is the densest populated country in Africa at around 480 people per km^2 with around 83 percent of the population living in rural areas (FAO, 2020). The country has a tropical-temperate climate with two main rain seasons: one in the beginning (March–May) of the year, and another one towards the end of the year (October–December) (Nsengiyumva et al., 2018). Additionally, the country has a double weather foundation explained by the phenomenon of the sun that crosses the equator around March, and the southern summer around September each year (Ndayisaba et al., 2016). The country is geographically bound by 1–3◦ S latitude, 28–31◦ E longitude. Between 2007 and 2017, the country achieved an impressive GDP growth at an average of

7.4 percent per year (NISR, 2018) and the agricultural GDP growth reached 6 percent in 2018 (MINAGRI, 2018).

The development landscape in Rwanda has significantly changed since the adoption of the Vision 2020 in the year 2000. To this end, the achievements made in less than two decades have given Rwandans much hope and belief to aspire for more accomplishments. The National Strategy for Transformation (NST1) which is also the Seven Year Government Programme (7YGP) comes at a unique moment in the country's development pathways which will see the crossover from Vision 2020 towards Vision 2050. This strategy is expected to lay the foundations for decades of sustained growth and transformation that will accelerate the move towards achieving high standards of living for all Rwandans. It will also serve as a guide of the national transformation agenda which aspires to make Rwanda an upper-middle income country by 2035 and a higher income country by 2050.

The NST 1 (2017-2024) picked up from where the Economic Development and Poverty Reduction Strategy (EDPRS2) left off, and continues in an effort to accelerate the transformation and economic growth with the private sector at the helm. With this new strategy, Rwanda's public policy focuses on developing and transforming Rwandans into a capable and skilled people ready to compete in a global environment. The NST 1 targets are ambitious but achievable. Realizing this potential will require strengthening collaboration and partnership among all stakeholders and enhancing ownership at all levels. Rwanda has achieved significant progress in the past, building on the same principles while tapping into its home-grown solutions and values. Therefore, both the vision 2050 and NST1 recognize the significant role that agriculture sector has played and will continue to play as a major driver towards this transformation.

The African Union (AU) Agenda 2063 has synergies with NST1 in creating a modern agriculture for increased productivity and production. More importantly, value addition and agribusiness development are reflected in the continental vision. The AU agenda is reflected in the Comprehensive African Agriculture Development Programme (CAADP) to reinvigorate African agriculture for poverty alleviation. As is the case for NST1, the AU agenda emphasizes water control and irrigation, improved land management, modern farming methods and commercialization meant to boost productivity and eliminate hunger. The priority area also reiterates Rwanda's commitment to the Malabo Declaration, especially on pursuing inclusive agriculture, agriculture finance, resilience to climate shocks and other measures for agriculture development, with an ultimate aim of ending hunger and eradicating poverty.

The Rwanda Livestock Master Plan (LMP) (Barry I Shapiro; et al., 2017) sets out investment interventions to help meet the national development plan targets of Rwanda by improving productivity and total production in the key livestock value chains. Investing in the small livestock sub-sector (including sheep, goat, poultry and others) is among the country's

development priorities. Modernizing the sub-sector can significantly increase income and household food, nutritional security, increase meat and egg production for domestic and export markets. However, the sub-sector faces a range of challenges regarding feed, genetics, and animal health, marketing and processing, including capacity-related issues. Regarding feed, for example, challenges include insufficient grazing areas to meet the feed needs of the animals, poor-quality grazing land resources and inadequate knowledge of the use of crop residues and by-products. The LMP presents a range of interventions including technical, capacity and policy-related to address these recurrent challenges. Here, a number of projects are currently operating in the sub-sector and a national platform on small livestock is at an early stage of development. The sub-sector would therefore benefit from increased capacity to innovate, collaborate and cooperate, and form an enhanced favourable policy environment.

Overall, agriculture modernization and productivity in Rwanda responds to and links up with global commitments to eliminate hunger as stipulated in Sustainable Development Goal 2. The interventions to promote agriculture mechanization, irrigation, post-harvest handling, among others, all seek to raise productivity of crops and livestock which will ultimately eliminate hunger, as envisioned by the global 2030 Agenda for Sustainable Development.

The current situation related to the outbreak of the Coronavirus in Rwanda has impacted the economic conditions of the rural household farmers and the economic performance of businesses. The Government has different roles to play in response to this crisis, and in its aftermath to ensure the economy recovers. In response to the current crisis, the government of Rwanda has defined policy options on economic recovery to overcome negative impact on the affected areas to restore the country's socio-economic development context so as to be stronger and more resilient. Among these is the establishment of the national economic recovery fund which aims to support the businesses hardest hit by COVID-19 so they can survive, resume operations and safeguard employment, thereby cushioning the economic effects of the pandemic. However, the implementation of the recovery approach requires concerted efforts across all business sectors but also strengthening capacity development and social protection to be able to stand firm against future emergencies (MINECOFIN, 2020).

4.2 Agriculture sector context

The Government of Rwanda policies for the small livestock sub-sector are in line with the current SDGs (2016-30) which focus on increasing production of affordable and nutritious products which contribute to the reduction of poverty, hunger and child mortality. In addition to nutritious food, small livestock farming produces high-quality organic manure, suitable to the development of sustainable farming ecosystems (Sitembo, 2020).

Rwanda relies heavily on agriculture for its income, employment opportunities and the economic well-being of its people. This sector remains the backbone of Rwandan economy and the main source of employment with 48.6 percent of the working age population over 16 years engaged in subsistence agriculture, and 51.4 percent employed in other sectors (NISR, 2020). Achieving food security and increased rural incomes will depend very much on increased productivity in the agriculture sector. Rwanda's reliance on agriculture as the main source of livelihood and employment presents an enormous challenge. Agriculture is majorly rain-fed and practiced by smallholder farmers with an average farm size of 0.6 ha (MINAGRI, 2018). Amidst these challenges, the trend of climate change and associated extreme weather events like prolonged droughts, floods and severe animal pests and diseases are posing a further risk to productivity, resilience, food security and farm income.

The promotion of agricultural innovation is given ample consideration in the current national agricultural policy. It is envisioned that research institutions and the private sector will be incentivized to pilot new technologies and business models that will increase quantity and quality of produce per hectare and animal Resources (MINAGRI, 2018). In addition, the recently adopted Fourth Strategic Plan for Agriculture Transformation (PSTA4) aims to build a strong and demand-driven agriculture research sector that develops and disseminates locally-adapted agricultural technologies and innovations to improve land, crop and livestock productivity and mitigate risks associated to climate change.

This strategy recognizes that increasing the resilience of Rwanda's agricultural productive system, including climatic risks, as well as the capacity to innovate and adapt, are key determinants for sustainable production, productivity increase, food and nutrition security (Bizoza et al., 2018). In addition, the Rwanda Livestock Master Plan prioritizes investment into small stock due to high rate of returns in shorter period of time with lower (affordable) capital of many households. However, for agricultural innovation system to take place and be effective, a conducive and enabling environment must be created. This comprises supportive policies, regulations and governance mechanisms that promote new ideas, new processes, new products and new forms of organization into economic use. In response to this, the GoR has put in place a range of sub-sector master plans, strategies and investment plans, such as: National ICT4Ag Strategy (2016 -2020); national dairy strategy and a master plan of the milk chain; master plan for fisheries and fish farming; strategic plan for animal nutrition improvement; strategy and investment plans to strengthen the meat, poultry, and small animal industries, respectively; and animal genetic improvement strategic and investment plan. Policies on fertilizers, rice and a mechanisation strategy are also present, among others.

Despite the growth and achievements in agricultural production, food security and agricultural export, the sector still faces challenges such as diseases, farmers' limited knowledge and capacities and lack of funds. To address these challenges, agricultural innovation features prominently in Rwanda's policies and strategies and 'strengthening

innovation and extension' has been identified as a new strategic orientation: Agriculture transformation requires research and innovation at the central level by introducing new varieties, disease mitigation, etc, as well as farmers' knowledge and skills to support specialization, intensification, diversification, and value addition.

4.3 Vision for development

Rwanda's vision for agricultural development agenda seeks to modernize and increase the productivity of Agriculture and Livestock, with an emphasis on promoting the commercialization of crop and livestock outputs, greater access to finance among farmers, increased mechanization and erosion control. This priority area responds to the fifth objective of NST1 which is to increase agriculture and livestock quality, productivity and production. This is also aligned with the EAC Vision 2050 which aims at increasing investments in the productivity of the agriculture sector.

To realize its vision, Rwanda has further set out its strategic directions to strengthen the commercialization of crop and animal resource value chains by increasing private sector engagement, promoting market-oriented agri-businesses, and capturing greater in-country surplus and value added. This will be done by increasing volumes of investment in the agriculture sector through the promotion of public private partnerships (PPPs). The existing market information system 'e-soko' (online marketplace for agricultural commodities) will be strengthened with the aim of expanding this service to provide ICT solutions to a broader set of challenges faced in the agricultural sector.

Research projects will also emphasize the interactions between extension workers and farmers to ensure research responds to the practical needs in the field, while the extension services programme will be expanded through the Twigire-Muhinzi model. In addition, the country will establish a programme to improve professionalization of livestock farmers and increase their output in terms of quality, volume and productivity. This will be achieved through improved animal health, enhanced research for increased productivity, promotion of local animal feed industries and processing of animal products with required standards and certification. Furthermore, the construction of dams and boreholes for livestock in drought prone areas will be scaled up and promoted as well as the storage of animal fodder.

To attract the private sector and farmers to invest in flagship projects in the livestock sector, the Government has facilitated different initiatives including: the construction and operationalization of Milk Collection Centers (MCCs); modern fish farming; animal feeds production; Gako beef farm; processing and value addition of leather. As a result, the quantity of meat and dairy products is expected to be increased, especially: milk from 776 284 tonnes (2017) to 1 274 554 tonnes (2024); meat from 138 231 tonnes (2017) to 215 058 tonnes in 2024 and eggs produced from 7 475 tonnes (2017) to 19 403 tonnes by 2024 (GoR, 2017).

Furthermore, the GoR has put in place mechanisms to increase access to finance for farmers, and established a financing programme including lease financing and insurance with a focus on priority value chains. As result, credits to the agriculture sector (primary farming and agro processing in agriculture, fisheries and livestock) as percentage of total loans (all sectors) is expected to double from 5.2 percent (2017) to 10.4 percent in 2024 (GoR, 2017).

Given the fact that performance of agricultural innovation systems requires effective facilitation of processes and actors involved, Rwanda has put in place agricultural sector Working Group (AgSWG). This facilitates coordination and dialogue between diverse stakeholders from government, the donor community, the private sector and civil society. As a result, the AgSWG has formed four Cluster Working Groups to oversee the various areas of cooperation expected between MINAGRI and stakeholders involved; for crop development, agribusiness, markets and export development, animal resources development, planning and budget, respectively. Each cluster is assigned a Chair from MINAGRI and a Co-Chair from development partners. Their role is to review the implementation of agriculture development strategies and achievements of the sector, create of state of a mutual understanding and accountability in realization of policy development processes.

4.4 Challenges and constraints to production and innovation

Despite the progress witnessed over the previous years, the agriculture sector in Rwanda is still hampered by a number of challenges and constraints that limit production and productivity on one hand while interrupting agricultural innovations on the other hand. These challenges can be traced from production to consumption stages. These include but are not limited to:

Small plot size and limited land availability limit productivity and profitability for most farmers: Rwanda is a small country, with arable land estimated to be 48 per cent of the total area of 26,338 km^2 (MINAGRI, 2018). Around 96 per cent of rural households rely directly or indirectly on agriculture for their livelihoods (MINAGRI, 2019; NISR, 2015). Although agricultural plots are generally small (average plot size is 0.6 ha often divided into three to four sub-plots), they cover a wide range (MINAGRI, 2018). About 30 per cent of the households cultivate less than 0.2 ha (accounting for about five per cent of total arable land), while about 25 per cent cultivate more than 0.7 ha (accounting for 65 per cent of the national farmland). 15 per cent of rural household farm less than 0.1 ha, many of which are female-headed households who cultivate only 1.32 per cent of national cultivable land (MINAGRI, 2018).

Land degradation acts as a major threat to agriculture performance: Although remarkable progress has been made towards the prevention and reduction of soil degradation through terracing and other measures, the topographic nature and environmental settings (a country of a thousand hills) combined with high and often intense rainfall lead to erosion, landslides

and soil degradation especially in the north-western parts of the country. While in the East, agricultural risks are related to pests and other diseases, erratic rainfall and periodic droughts that limit agricultural productivity. This causes consequences for individual farmers and rural communities. In addition, soil acidity negatively impacts on the agriculture productivity. According to the government's state of environment report (REMA, 2009), about three-quarters of Rwanda's soils are acidic, with a pH below 5.5 and a deficiency in nitrogen or in phosphorus.

Agricultural commodity markets and value chains affect both farm profitability and food security: There are many challenges and constraints in value chains, which inhibit the flow of agricultural products from the farm gate to processors, export markets, and consumers. These relate to issues of market infrastructure, market access, market information, logistics, and regulations in trade. Limited access to agricultural finance products constrains subsistence farmers' ability to take measured risks to increase productivity and/or profitability. The agriculture sector has therefore specific financing needs, which are different from most of available commercial banking products that target urban real estate markets and the formal sector.

The skills gaps in agriculture limits productivity and profitability: Formal education levels among rural remote smallholder farmers are generally low. According to MINAGRI (PSTA4) 66 per cent of agricultural operators had attended primary level education, 26 per cent had no education, 6.6 per cent attended secondary level education and only 1.4 per cent had attended tertiary level education, noting a gender difference. However, beyond formal education, farmers require a range of agronomic and farming as well as business skills to optimize land and cropping practices as well as making well-informed investment choices for greater production/profitability.

Rwanda needs to innovate because the agriculture sector is constrained by numerous challenges and constraints mentioned above. This implies that there is a need to do things differently. To overcome these constraints and challenges, the following should be addressed to support smallholder farmers to innovate:

- Produce transportation is costly due to inaccessible urban rural road network.
- Quality standards of local produce against regional and international market requirement standards.
- Price volatility of export produces.
- inadequate access to markets.
- Low human capacity in agriculture sector.
- Small existing base of agro-processing.
- Lack of access to agriculture finance and long-term credit and inadequate access to advanced technologies.
- limited rural infrastructure.
- High production (labour intensive, high cost of utilities) and transport costs.

- Farms are simply too small to produce a marketable surplus and as a consequence they cannot farm their way out of poverty or malnutrition.
- Land fragmentation having distinct geographic characteristics.
- Predominance of subsistence farming of staple crops for self-consumption. These farmers are being faced by challenges that suppress yields below their potential, such as limited insurance, technology, skills, irrigation, mechanization, seeds, fertilizers, and other key inputs.
- The business in the sector is dominantly informal which limits investments and resource.
- Limited use of evidence-based research to inform decisions and policy making processes within the sector.

COVID-19 pandemic impacts including unemployment, prices increase, travel restrictions which resulted into business closure, loss of hope and despair, lack of starting capital in the aftermath of the pandemic crisis. In this regard, the Economic Recovery Fund (ERF) was established by the Government of Rwanda to support the rehabilitation of businesses in the sectors hit hardest by COVID19 pandemic so that they can survive, resume operations and safeguard employment, thereby cushioning the economic effects of the pandemic (MINECOFIN, 2020).

5. Overview of the AIS assessment process

5.1 Organization of the assessment

The AIS assessment in Rwanda was conducted by the Institute of Policy Analysis and Research (IPAR-Rwanda), an independent think-tank aiming at improving policy and impacting change in Rwanda. The research team of ten researchers included one quality assurance expert, the Director of Research, one lead researcher, two team leaders and six research assistants (Annex.1).

A short training course on the FAO AIS Assessment methodology was held on 2-7 December 2020. The virtual training combined presentations, group work and discussions. However, a total lockdown due to COVID-19 delayed the implementation of the AIS assessment. In response to that situation, a refresher training was organized on 8-10 February 2021 to repeat and clarify critical aspects of the assessment methodology.

Due to the Covid-19 pandemic restrictions the AIS assessment team could not organize physical workshops or gatherings during the data collection phase as initially planned. Most staff from the public sector (Ministries, Districts, and NGOs) were still working from their homes, and others had tight schedules making them unavailable for interviews, which necessitated postponement of interviews in some places. Data collection in the field could finally start in April 2021 in the City of Kigali and in Rwamagana, Bugesera, Rulindo and Gicumbi Districts.

During the assessment, the research team regularly consulted with FAO-Rwanda, the National Project Coordinator (NPC) at MINAGRI, and the TAP-AIS project's country advisory team. The project team from FAO Rome, Italy, provided guidance to ensure alignment with the global project.

Key informant interviews (KIIs) and focus group discussions (FGDs) were used to gather information on knowledge, experiences, and opinions from respondents in the agriculture sector. Overall, a total of 12 FGDs and 42 KIIs were conducted for the case studies. Additionally, 22 key experts were interviewed for a capacity gap analysis at the national level.

Secondary data sources relevant to the assessment were reviewed (key project documents and other materials/documents that deal with small livestock sub-sector in Rwanda to identify gaps and areas for improvement at enabling environment level). These included the Rwanda Livestock Master Plan (LMP), the national agriculture policy of 2018, the strategic plan for agriculture transformation 2018-24 (PSTA4); MINAGRI annual reports 2016-17, 2017-2018, 2018-2019; the national strategy for transformation (NST1). In addition, scientific papers were consulted to contextualize the enabling environment and policy context, specifically on the three selected case studies.

5.2 Entry points and case studies

The AIS assessment of the small livestock sub-sector in Rwanda used three case studies as an entry point. Taken together, the case studies gave a representative picture of the AIS for the small livestock sub-sector. Their selection was done in consultation with relevant institutions including MINAGRI, RAB, development partners and FAO, among others. The three cases studies, which covered different kinds of innovation and involved a wide range of stakeholders from local to national level, were the following:

Case study 1: Introduction of the Sasso breed dual-purpose chicken in Rwanda

Through public private partnerships (PPP), the MINAGRI privatized the National Hatchery at Rubirizi in 2017, to encourage development of new, decentralized mini-hatcheries across the country. Uzima Chicken Ltd, which took over the hatchery, intends to transform the poultry industry in Rwanda by reaching out to smallholder rural farmers with a robust breed called Sasso, a dual-purpose chicken that avails both meat and eggs, and which thrive in local rural conditions. According to Uzima Chicken Ltd, it is four times more productive than local chicken. The company aims to achieve two chicken per household by the end of 2021, and one chicken per person per year in 2025 to over seventy-five million people in East Africa.

Uzima Chicken Ltd. is located in Kanombe Sector, Kicukiro District in the city of Kigali. It has recently invested in a new high-quality hatchery facility in Bugesera District in eastern Rwanda, with the objective to expand production capacity to between eight and ten million birds per year. The goal is to boost domestic supply of day-old chicks of this improved breed and create an added value to the smallholder farmer level, through better quality meat and

eggs for consumption and sales within the country and in the region. Uzima Chicken operates through a network of 660 locally placed sales agents (mobilisers) countrywide who supply vaccinated day-old chicks and provide a full solution package related to training, feed, vaccines and medicine in order to raise and sell chicks to rural smallholder farmers. The company also works with independent distributors/entrepreneurs, majority of them youth and women, who market Uzima Chicken Ltd products and take chicken orders.

Figure 1: Uzima chicken mobilizers in Rwamagana District

The distributors rear the chicken for six to eight weeks and then sell them to smallholder farmers. Chicken are distributed to farmers through its distribution model and community based mobilization is done in people's homes, especially in remote areas. Uzima Chicken Ltd has another unique distribution model known as ''door to door'' delivery through coordinating free dispatch to its clients especially in urban areas. It also supports its clients by brooding and distributing quality one-week or one-month old chicken.

Case study 2: Artificial insemination for improved piggery farming

Located in Kisaro sector, Rulindo district within the Northern Province of the country, the Centre de Perfectionnement Agricole (CPA), an NGO with Belgian roots, promotes agriculture and small livestock farming since the mid-1970, in collaboration with the Government of Rwanda. In 2009, CPA introduced artificial insemination for improved piggery farming. The organization provides insemination kits for landrace and Piétrain breed to rural smallholder farmers and organize training on how to use artificial insemination in a professional manner. Community members appreciated the speed with which piggery can multiply and their fast growth rate. Through Government support and community initiatives, some community members have been able to start piggery businesses.

In 2013, MINAGRI-RAB facilitated CPPA in the construction of a fully equipped laboratory to enhance research and development aimed at increasing production of new pig breeds, and to provide an upgraded piggery insemination facility. CPPA is the sole provider of artificial

insemination in pigs in Rwanda, using semen imported from Belgium, complemented by semen from elevated local pigs. CPA offers scholarships to 30 students annually in multiple disciplines including six months of specialization in in piggery farming.

Figure 2: Landrace breed at CPPA-Kisaro, Rulindo District

CPPA works on a daily basis with the community around Kisaro and beyond who are directly engaged in piggery farming. The community members are now confidant because the center supports them in terms of marketing of their pork meet and has introduced food processing for making sausages and other pork products. Additionally, CPA offers training on animal feeding and crop production, technical advisory services on both animals and crops, and assists farmers to understand veterinary activities and services. Such strategies and changing mindsets regarding eating pork meat have contributed to the growth of the industry as demand for pork has sharply increased. Other contributory factors in the production of improved pig breeds are efforts by the government of Rwanda and other stakeholders including agronomists and veterinarians to fight disease such as swine flu.

Case study 3: Introduction of the animal feeds industry in Rwanda

Animal feeds factories are emerging in Rwanda as a result of high demand for animal feeds among large and small-scale livestock farmers. Before 2015, there was no well-established animal feed industry in Rwanda and farmers used to source feeds from factory by-products as well as importing other ingredients to mix. The cost of feeds in Rwanda is the main expense in small livestock farming such as poultry and piggery, estimated to be between 60 and 70 percent of the input costs. This constituted a feed industry gap which prompted the establishment of a number of feeds industry companies. Currently, six different factories produce animal feeds, something that was not there before. This has significantly contributed to increased livestock production.

Figure 3: Animal Feeds Factory in Rwamagana District by Uzima Chicken Ltd.

One of the most prominent and innovative animal feed companies in Rwanda is Gorilla Feed Co. Ltd. It was established in 2015, with the aim to improve livestock farming in Rwanda and other East African countries and providing a solution to problems farmers have been facing in regard to accessing animal feeds in the country. Gorilla Feed Co. Ltd. is located in Kigali, Rwanda and is expected to produce over 600 tons per month.

It aims to avail animal feeds at affordable price as raw materials are from Rwanda. Its most innovative approach is to serve farmers using the model "*Tuzamurane*" literally meaning ''Let us grow together". This implies that the animal feed Industry can grow only if farmers also grow. Under this model, Gorilla Feed Co. Ltd. has come up with new ways to support farmers through land consolidation by growing maize, wheat, rice etc., which in turn are supplied to the industry for producing animal feeds. The feeds are therefore made from maize, rice bran, wheat bran, fish products and soybean.

5.3 AIS assessment approach and methodology

The AIS assessment followed a methodology developed by FAO*: Guidelines for action-oriented assessment of agricultural innovation systems (AIS).* The FAO assessment framework (Figure 4) has four integrated steps which are briefly described below.

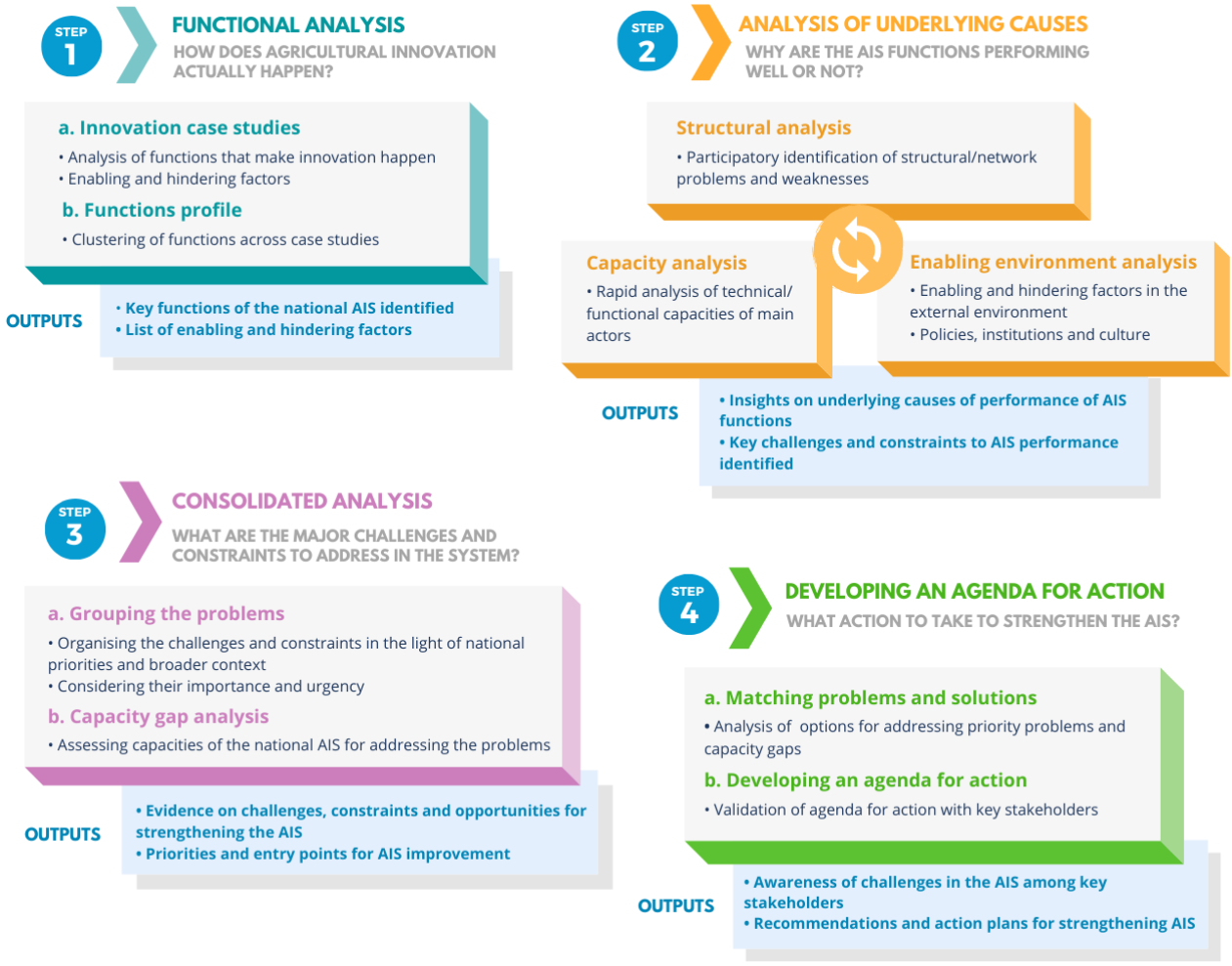

Figure 4: Standard steps and outputs for the action-oriented AIS-assessment

Step 1. Functional analysis

To understand what is actually happening in a particular innovation/situation, the functional analysis, step one (1) of the study, analyzed the innovation processes using three case studies (reference to case study descriptions). The analysis combined focus group discussions (FGDs), semi-structured interviews with key informants, and SWOT analysis. Factors that enable or hinder the performance of AIS for small livestock sub-sector in Rwanda were listed. Dialogues and brainstorming in small groups were organized with key informants in the small livestock sub-sector, to draw out the functions of a case study well. This was complemented with secondary data information. Analysing the findings across the three case studies allowed the identification of set of core functions in the innovation system.

Step 2. Understanding underlying cause of performance

The functions identified in Step 1 were further analysed in Step 2 with regard to structure, capacity and enabling environment.

Structural analysis: The structural analysis aimed at identifying and describing the actors of the innovation system, and their interactions and networks, to identify structural reasons behind the performance of the functions. The analysis combined stakeholder analysis and network analysis. This structural analysis was performed at a sub-system level (for instance research and education, agricultural advisory services, innovation support services, private firms). The social network analysis was carried out in a participatory manner through deliberative forums, focus group discussion and key informant interviews.

Capacity analysis: The emphasis of the capacity analysis was to capture capacity issues in the small livestock sub-sector overall, related to the functions identified earlier. Current, existing capacities as well as needed capacities/capacity gaps were listed, by function. For this analysis interviews with key informants who have good perspective of agricultural innovation systems in Rwanda were employed.

Environmental analysis (enablers and disablers): The environmental analysis assessed how the policy and legal framework and other external factors influence the innovation performance in organisations and individuals from national to local levels. This analysis identified the key factors that provide incentives for, or constraints to innovation. This analysis was conducted through focus group discussions, semi-structured interviews, SWOT analysis and document reviews (small livestock related policies, legal and regulatory framework, infrastructure, investments, institutional aspects, and key policies and strategies including the Rwanda Livestock Master Plan.

Step 3. Consolidated analysis of system problems and opportunities

Consolidated analysis: This step of the assessment considered all the findings of Steps 1 and 2, consolidating them at systems level and clustering the information into key themes that need to be reflected upon and prioritized. Two tables of consolidated findings were drawn up: (i) Challenges and constraints, and (ii) Enabling factors and opportunities. In this phase, consultations took place with key stakeholders including the TAP-AIS project's country advisory team.

Capacity gap analysis: A capacity gap analysis was conducted using a scoring tool. This was a macro-level analysis of capacities to strengthen the national AIS. Covering six domains of a national innovation system, it took stock of the national or 'systemic' capacities to address the challenges and constraints identified in the AIS assessment. Twenty-two key experts were interviewed for the capacity gap analysis using semi-structured interviews. The information will help action plans for capacity development plans for agricultural innovation in the country, aiming at improving the small livestock sub-sector.

Step 4. Identification of actions to take

In this the final Step, the AIS assessment team developed recommendations on how to solve the identified issues/problems and strengthen capacities of the national innovation system.

The AIS assessment team tried to look at different options, make appropriate recommendations, and suggest realistic actions. The capacity development phase of the TAP-AIS project are in focus, regarding developing capacities of key organizations of the small livestock sub-sector, and at the policy level.

6. Main findings of the assessment

6.1 Functional analysis

The functional analysis was based on the consolidated results of the three case studies of the small livestock sub-sector. The AIS assessment identified eight key functions in the agriculture innovation process in Rwanda. These functions helped to identify key actors, institutions, networks, and services that support agriculture innovation systems in Rwanda. These consisted of the following (Table 1).

Table 1: Major functions identified in AIS in Rwanda

#	Function	Description of the Function
F1	Capacity building for rural smallholder farmers.	Enhancing technical capacities, skills and abilities of the small holder farmers, organizations and institutions through training, coaching and mentoring of functional and technical skills (soft and hard skills). The development of skills for farmers, youth and women will help to alleviate poverty in the long run, by creating economic opportunities.
F2	Technical support and advisory services.	Technical support by agronomists, veterinarians and community mobilizers to farmers within the small livestock sub-sector. That can be done through meetings, trainings, workshops, demonstrations, site visits and advisory, on-the-job training, mentorship, farmer field schools, group discussions and consultations. Technical areas include animal husbandry for small livestock, promotion of good practices and innovations, and appropriate medication for the animals.
F3	Research and knowledge generation.	Research capacity and knowledge generation upgrading are at the apex of agriculture growth. This must be aligned with an extension system that stimulates feedback mechanisms from the producers to ensure research and extension services are demand-driven. A strong and demand-driven research and knowledge generation underpins dissemination of locally-adapted inputs, technologies and innovations and will improve productivity and mitigate risks within the small livestock sub-sector in Rwanda. This function also involves capacity building of research staff and academia (UR/CAVM, RAB, NIRDA etc.). This will boost the application of research findings through innovative new technologies and strategies while increasing resilience and sustainability.

F4	Communication and awareness creation.	For community awareness creation, different materials and approaches can be applied such as: TV and radio shows, posters, brochures, official documents, small evening meetings/gatherings, banners, field visits (come and see, go and implement), awareness campaigns and mobilizations of the small rural farmers. Also, communication platforms need to be established for information sharing/exchange.
F5	Coordination, community mobilization and involvement to increase productivity.	Networking, coordination, facilitation and establishment of working groups, platforms, groups, and organisations dialogues, discussions, round table sessions, community engagements and solving problems.
F6	Market linkages and commercialization.	Providing facilitation to access market, price negotiation skills, market information, resource mobilization, access to credits, etc. Existence of specialized markets.
F7	Transportation of small livestock (chicken, pigs and pork).	Road network for rural-urban linkages (feed roads, district roads etc), Availability of specialized trucks to transport meat, eggs, and other related products.
F8	Access to finance and resource mobilization.	Access to credits or funds to be able to operate, starting capital, and facilitation of access to inputs for poor and vulnerable rural farmers

6.2 Structural analysis

The structural analysis was conducted to identify key organizations delivering the AIS functions of the small livestock sub-sector in Rwanda. This analysis was done using desk reviews and qualitative approaches including key informant interviews and Focus Group discussions. In total, 36 organisations were identified including government agencies, development partners, the private sector, producer groups, and Civil Society Organizations (CSOs) and local government entities (district and sector levels).

Table 2: Structural analysis for key functions in agricultural innovation system

#	Function	Structural Analysis: Key organizations delivering functions
F1	Capacity building for smallholder farmers.	• Ministry of Agriculture and Animal resources (MINAGRI), • Rwanda Agriculture and Animal Resources Development Board (RAB) • Districts Agronomists and veterinary officers • Sector-level agronomists • Uzima chicken Limited • Centre de Perfectionnement et de Promotion Agricole (CPPA- Kisaro) • Community Animal Health Workers (CAHW) • Gorilla Feeds Co. Ltd. • Private Sector Federation • Livestock Farmer Field School Facilitators (LFFS) • NGOs.
F2	Technical support and advisory services.	• MINAGRI • RAB • District and Sector level agronomists • Centre de Perfectionnement et de Promotion Agricole (CPPA)- Kisaro, (Veterinarians for artificial insemination ; Advisory services) • Uzima chicken Limited (Advisory services) • Rwandan Veterinary Organisation • Rwanda Council of Veterinary Doctors (RCVD) • New vision veterinary hospital (NVVH) • Vision Agribusiness Farm Limited (VAF) • Rwanda Youth in Agribusiness Forum (RYAF) • Rwanda Animal Scientists Organisation (RASSO) • Rwanda Animal Resources Improvement Cooperative (RARICO) • Youth Engagement in Agriculture Network (YEAN) • Send a Cow-Rwanda.
F3	Research and knowledge generation.	• RAB • University of Rwanda (CAVM), • National Industrial Research and Development Agency (NIRDA) • Institut d'Enséignement Supérieur de Ruhengeri-INES • Rwanda Institute for Conservation Agriculture (RICA) • University of Lay Adventists of Kigali (UNILAK) • Rwanda Youth in Agribusiness Forum (RYAF) • Incubation center in agribusiness.
F4	Communication and awareness creation.	• MINAGRI • RAB • District agents • Uzima chicken Ltd. (distribution agents at village level) • Veterinarians and sector agronomists, • Farmers' association • Community leaders (cell and village levels).

#	Function	Structural Analysis: Key organizations delivering functions
F5	Coordination from national to local levels, community mobilization and involvement.	• MINAGRI • RAB • Districts • Community members at the local levels • Private Sector Federation • Civil society organizations (CSOs), • Local leaders (sector, cell, village and *Isibo* Levels).
F6	Market linkages and commercialization.	• Central Government (infrastructure development, e.g. rural-urban road networks), • MINICOM • Private entrepreneurs • Districts • RAB • Uzima chicken Ltd. (strong network of agents) • Faith-based organizations • International and local NGOs • Financial Institutions • Access to Finance Rwanda (AFR) • Farmers' Association.
F7	Transportation of small livestock (chicken, pigs and pork).	• MININFRA • MINAGRI • MINICOM • Districts • Private entrepreneurs • Private Sector Federation.
F8	Access to finance and resource mobilization.	• Central Government • MINALOC • MINICOM • MINECOFIN • MINAGRI, • Rwanda Cooperative Agency (RCA) • Rwanda Development Bank (BRD) • RAB • PSF • Districts • Commercial Banks, micro-finance institutions, Savings and Credits Cooperative (UMURENGE SACCO) • INGOs (IFAD etc.) • LNGOs • International NGOs • Business Development Fund (BDF).

This AIS assessment analysed the relations and systems within the agriculture innovation in the country (**Figures 5a, 5b, 5c**). The results of the network analysis showed involvement and interactions of different players who perform various functions to support innovations within the small livestock sub-sector in Rwanda.

The levels of interaction are represented using different colours where the green shows higher interaction, amber for the medium interactions and blue represents less interactions. Description for the net-maps are the following:

Figure **5a** represents capacity development for smallholder farmers in the small livestock sub-sector. The net-map shows that there is strong linkages between RAB-MINAGRI; MINAGRI-Districts; RAB-Districts; Districts-Sectors; Uzima Chicken Limited-Gorilla Feeds Industry; VAF-Districts. All these actors play an important role for capacity building of farmers across the small livestock sub-sector.

The second net-map (Figure **5b**) shows connections between actors who participate resource mobilization and access to finance. It can be seen from the figure that there is a strong link of actors between: MINALOC – districts; MINALOC – local leaders; PSF – private operators; INGOS – districts; MINICOM – private operators, MININFRA – Districts, Local NGOs – MINALOC, and UZIMA Chicken Ltd – private operators. However, a weaker link was noted from the analysis between Uzima Chicken Ltd and international NGOs, CSOs and MINICOM as well as MINALOC and veterinarians and agronomists at sector levels.

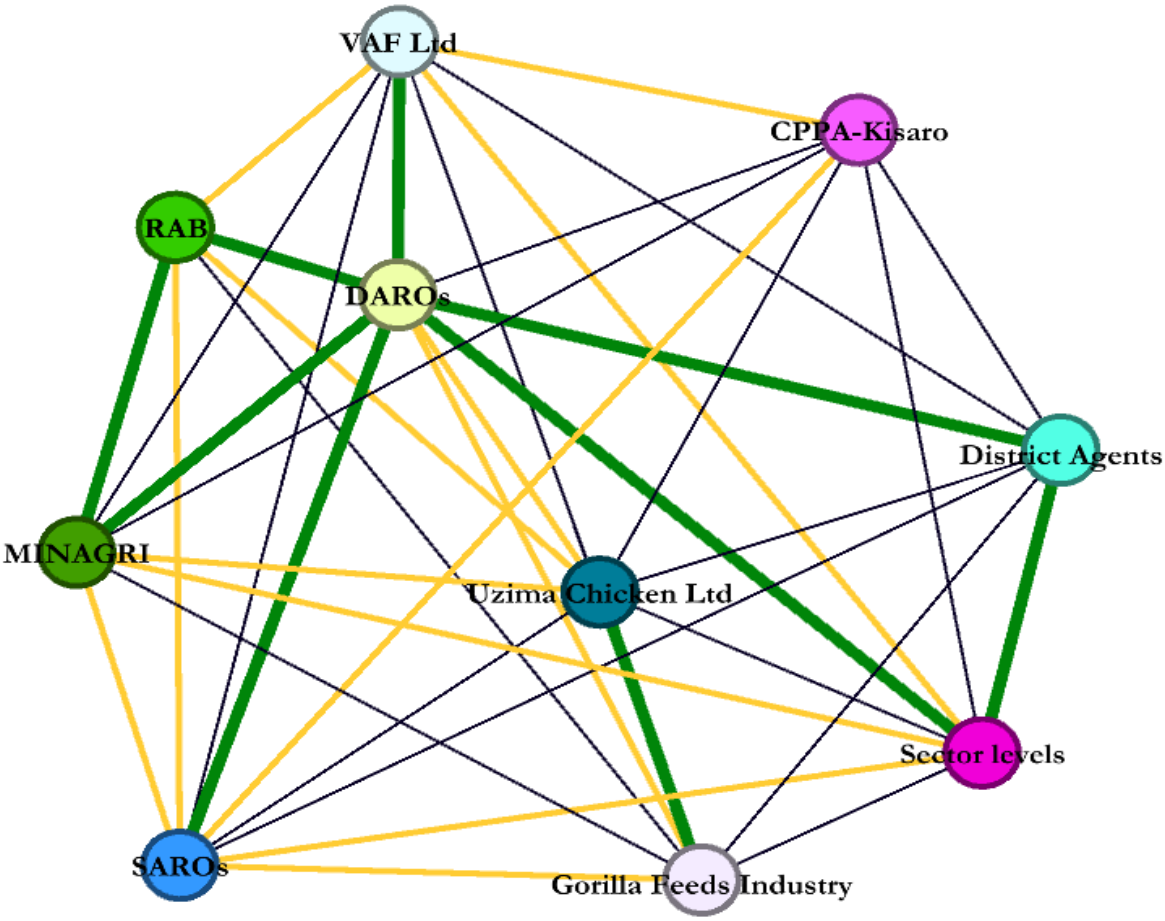

Figure 5*a*. Net-Map of capacity development of smallholder farmers

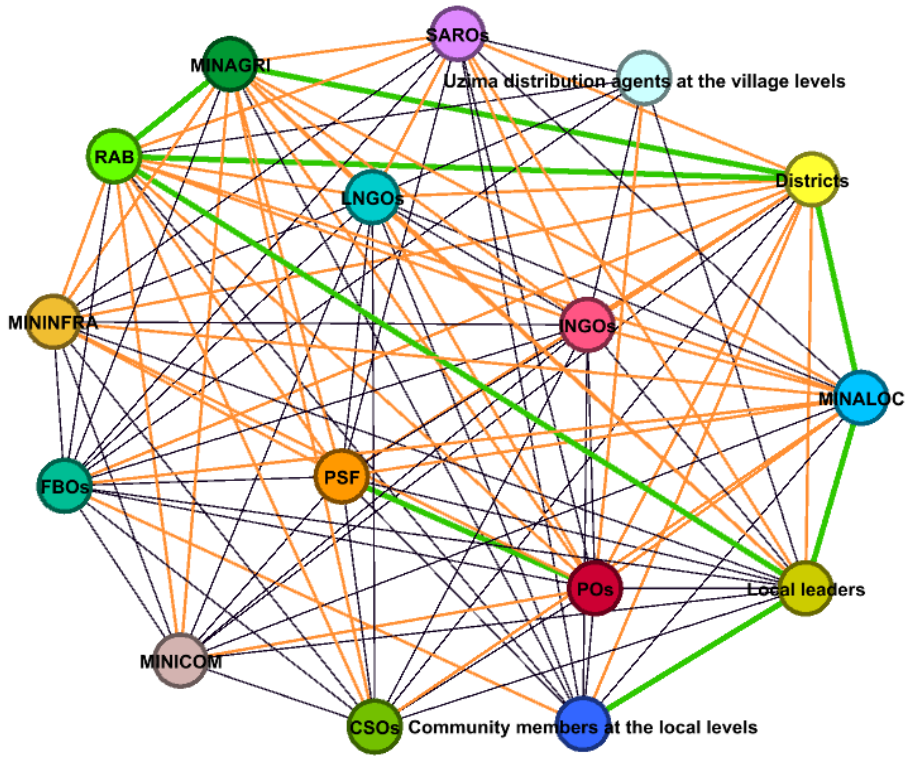

Figure 5b. *Connections between actors regarding access to finance and resource mobilization*

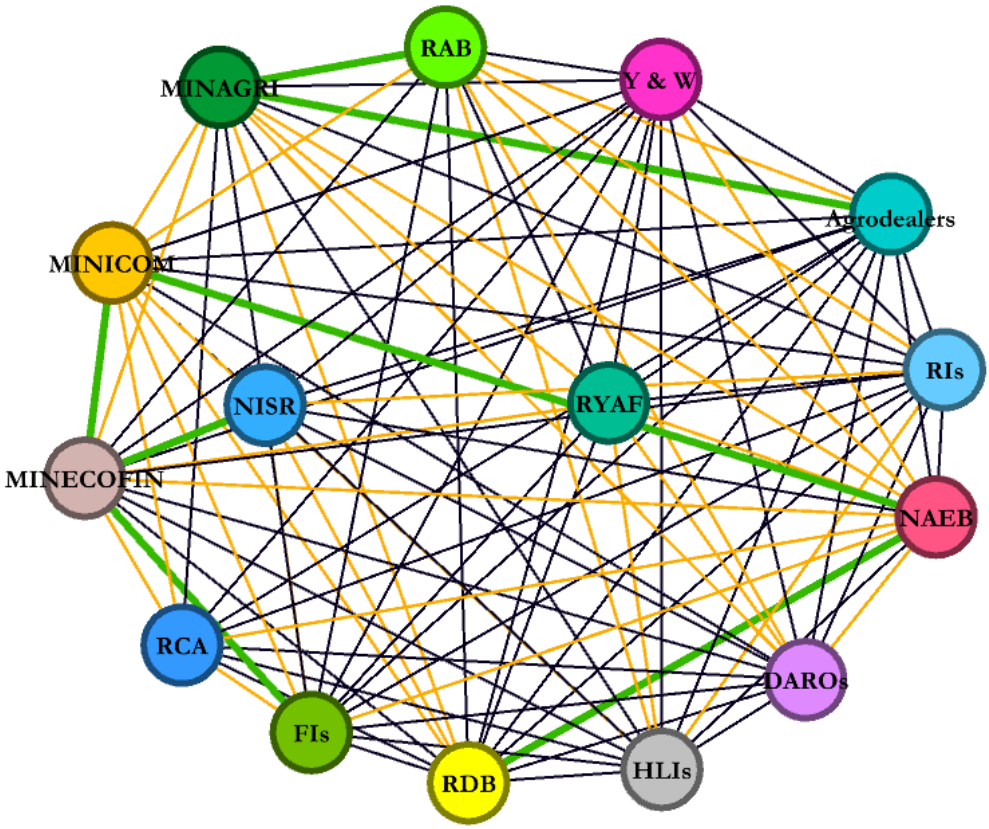

Figure 5c*: Network analysis for research and knowledge generation*

The third net-map (Figure 5c) represents actors involved in the research and knowledge generation function. The analysis shows that there is a strong link between research institutions and HLIs; MINECOFIN and RCA; RCA and Financial Instutions, RYAF and women/youth; agro dealers and District veterinary officers; NAEB and RDB, etc.

It is important to note that in all three net-maps there are good working relationships among all the key actors towards promoting the small livestock sub-sectors. With reference to the produced net-maps, the participating institutions such as Uzima Chicken Limited, CPPA, the Gorilla Feed Industry, Vision Agribusiness Farm Limited (VFA) and districts/sectors work closely with small holder farmers in remote rural areas as well as in urban settings.

6.3 Capacity analysis

The capacity analysis looked into the current capacities of actors to perform the key functions, and also identified needed capacities/capacity gaps that hinder the performance.

Table 3: Capacity analysis for key functions in the innovation system

	Function	Current Capacities	Needed Capacities/Capacity Gaps
F1	**Capacity building for smallholder farmers.**	• Some farmers are starting to get involved in the animal husbandry and value chains of improved small livestock (new and improved breeds).	• Capacity gap between progressive innovation actors involved agricultural transformation, and those who are not. • There is a knowledge gap among small holder farmers in regard to technical know-how on taking care of chicken and pigs. • Capacity development scheme on seed multiplication as a business, for animal feed.
F2	**Technical support and advisory services.**	• Presence of an extension and advisory service network from national to sector level. • Each District and Sector has its own agronomist and veterinarian, supporting local farmers. • Research institutions and University of Rwanda with specific programmes on small livestock.	• Technical support services are required especially in detecting new diseases, and regarding good practices for heating and lighting for day-old chicks and piglets. • Need to strengthen advisory services in terms of appropriate feeds requirements for chicken and pigs of different age. • Extension and advisory services to increase its focus on markets. Poor market information is a major constraint to farmers' participation in value chains. • Finding solutions to the increased mortality rate in chicken

	Function	Current Capacities	Needed Capacities/Capacity Gaps
			• Quantity and quality of nutritious feeds for the pigs and poultry flocks needs to be improved: there is insufficient production capacity for animal feed in Rwanda, and poor access to feed in remote areas. • Limited evidence-based research results to inform the decision and policy making processes in the small livestock sub-sector.
F3	**Research and knowledge generation.**	• Knowledge generation through RAB, UR, NIRDA, NISR, LODA, RGB.	• Insufficient budgets for research and knowledge generation in the small livestock sub-sector. • Research products and findings are not well disseminated. • Limited private-sector investment in research and development in the small livestock sector. • Technical and vocational training institutions need to put more emphasis on practical skills in small livestock husbandry.
F4	**Communication and awareness creation.**	• Through RAB and MINAGRI, communication linkages exist from the Government to the local level.	• Lack of strong communication and coordination mechanisms between smallholder farmers and suppliers, veterinaries and agronomists. • Farmers request a platform for communication with distributors of animal feeds and breeds explore opportunities together and find solutions to problems. • Pharmacists and veterinary officers working together through a platform to discuss animal health problems in small livestock.
F5	**Coordination from national to local levels, community mobilization and involvement.**	• Presence of a domestic animal feed industry, that cuts costs of imported feeds and improve stakeholders' knowledge and capacity in animal nutrition.	• Gap in communication and information flow between smallholder farmers and the national level. • Creating a strong platform for community involvement and feedback mechanisms. • Adopting a culture of land consolidation: community mobilizations for land consolidation is highly needed. • Development of public-private partnership (PPP) in feed

	Function	Current Capacities	Needed Capacities/Capacity Gaps
			manufacturing can unlock its potentials.
F6	**Market linkages and commercialization.**	• Government through the Ministry of Trade and Industry and also Ministry of Local Government engage in regulating value chains to increase revenues at farm level.	• Creating awareness and skills in controlling sanitary standards of small livestock needs to be given much attention (poultry flocks and pigs). • Capture the potential for participation in national, regional and international trade through promotion of a high quality made-in-Rwanda products. • Smallholder farmers face marketing challenges: there is need for capacity development for business management, and financial and market literacy to strengthen market and value chain orientation.
F7	**Transportation of small livestock and their derivative products (chickens, pigs, meat).**	• Some refrigerated trucks exist, but capacity is insufficient. • Local bicycle networks distribute day-old chicks at Sector level. • Partnership between Ministry of Infrastructure and Ministry of Agriculture.	• Improved capacity for transportation of live animals such as pigs, chicken or a day-old chicks, as well as eggs and pork in specialized trucks and appropriate baskets, to enhance animal welfare.
F8	**Access to finance and resource mobilization.**	• Rwanda Cooperative Agency supports farmers' groups in accessing finance. • Government of Rwanda give tax (VAT) exemption for small livestock sub-sector, and also engage in public-private partnerships.	• Better business management and organizational skills, and financial literacy to enable entrepreneurs and farmers to access and use financial services.

Capacity gap analysis at national level

The GPA assessed the national level capacities to change and improving the AIS. The analysis used information and data collected from 22 national experts from the government, donor community, international organizations as well as agricultural research institutions (Annex 3). Using a scoring tool. Respondents ranked six capacity domains based on their experience and knowledge of the agricultural system (Figure 5). This analysis identified specific gaps in capacity domains, information that will help to elaborate national capacity development plans for agricultural innovation, including for improving the small livestock sub-sector.

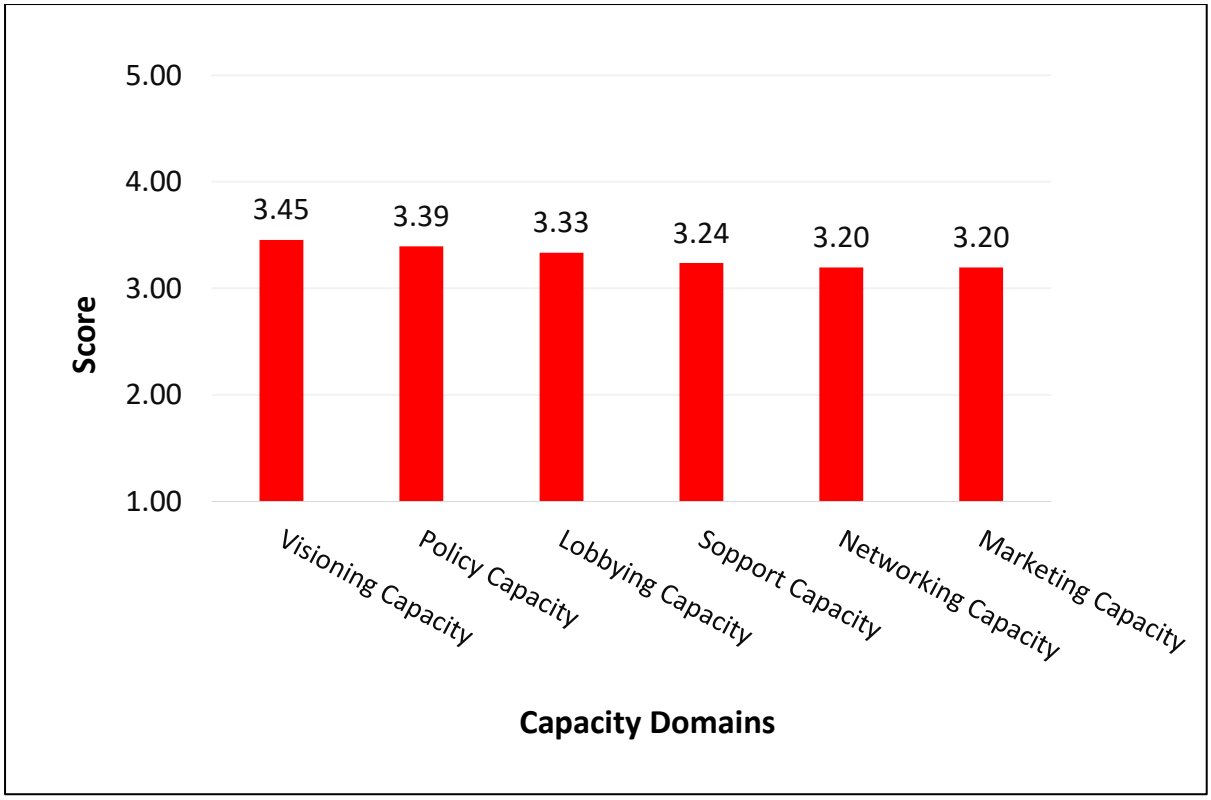

Figure 6: Capacity gap analysis for the AIS assessment in Rwanda

Scores	Interpretation
<1	Inexistent; need to be created
1<x<2	Existent but ineffective; need to be refined/refocused
2<x<3	Existent but in a too limited extent; need to be extended/developed
3<x<4	Existent; well-developed but could have more effects; need to be enhanced further
4<x<5	Good; no support /extension needed

The capacity gaps analysis (Figure 6) indicated that there are very small variations across the six capacity domains. The scores varied from 3.20 to 3.45, the lowest-scoring domains being marketing capacity and networking capacity, respectively.

Within capacity domains, actors' knowledge and skills were generally rated higher than their capacity of putting those into practice, and their capacity for continuous learning and improvement. The capacity to create new markets is a case in point (Figure 6). It is a common case in different institutions in Rwanda that people do not put their knowledge into practice due to a number of reasons including limited capacities to acquire necessary resources, organizational culture, etc. Results indicated that all the systemic capacity domains of AIS are existent and fairly well developed, but that they can be enhanced further. This means that a lot still need to be done in terms of capacity building of various institutions to respond to their vision, missions and mandate in developing the small livestock sub-sector.

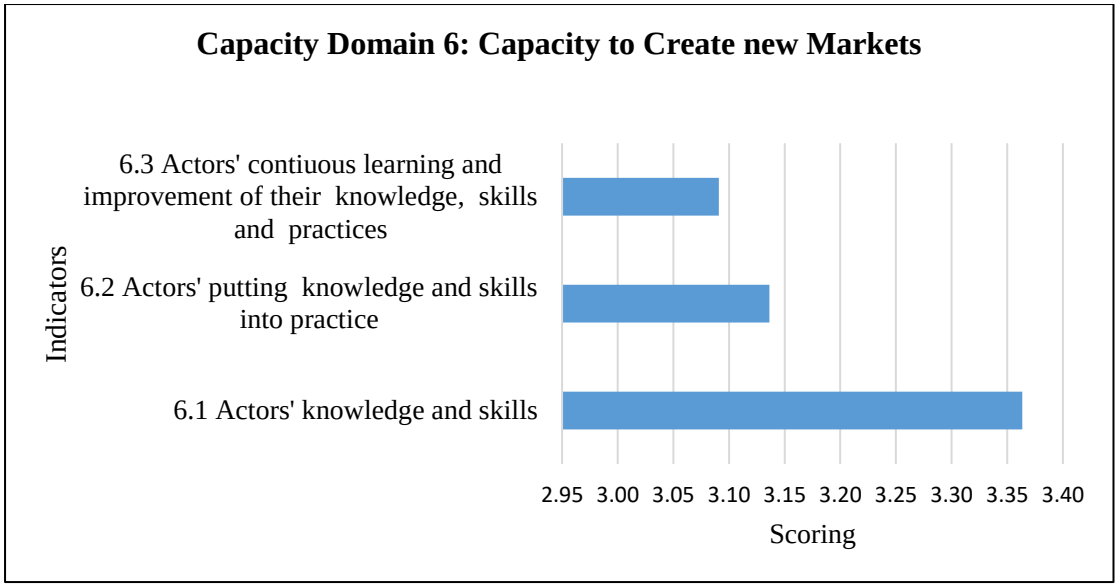

Figure 7: Capacity to create new markets

Prioritized areas of capacity development for the small livestock sub-sector in Rwanda

Overall, the capacity analysis indicated the priority areas for capacity development within the small livestock sub-sector. The identified areas cover both technical and functional capacities, often in combination, at both individual and organizational levels. Some of the issues also relate to capacities at the policy/enabling environment level. These are the pressing issues that need to be understood by stakeholders.

Coordination, collaboration and networking: The responsibility for small livestock is fragmented across different organizations, creating coordination challenges regarding extension and advisory services, farming inputs and off-take of products to markets. A national platform on small livestock is at an early stage of development, but is not yet fully active in supporting the sub-sector. Farmers also request a platform for communication with distributors of animal feeds and breeds to explore opportunities together and find solutions to problems.

Markets and value chain development: Marketing capacities and market orientation within the small livestock sub-sector needs strengthening to address weak links in value chains. Capacity to identify and address bottlenecks in value chains of piggery and poultry involving remote rural areas needs to be further developed. Poor market information is a major constraint. There is also need for capacity development in business management among small-holder farmers/farmer organizations and small entrepreneurs. Extension and advisory services need to increase its focus on markets. Trade promotion of a high quality made-in-Rwanda products require a national-level support.

Animal health and animal husbandry: A number of issues around animal health emerged, which involves feeds, management and veterinary services. Quality and quantity of feeds accessible and affordable to farmers, also in remote rural areas, needs to be improved.

Farmers' capacity in detecting and treating animal diseases need to be strengthened and the coverage of veterinary services improved. Good practices in animal husbandry of small livestock need to be disseminated through communication and training for farmers and at training institutions.

Transportation and logistics: Limited capacity for refrigerated transport as well as for transport of live animals are bottlenecks in the small livestock sector. Traditional practices (use of wooden boxes on bicycles) are not always appropriate and lead to mortality in chicken or piglets in hot or wet weather conditions. Day-old chicks and piglets may suffer during long-distance transport.

Access to finance, and resource mobilization: The financial literacy, business management and accessing financial services need to be improved among rural small-holder farmers/farmer organizations and entrepreneurs. At national level, there is insufficient budgets for research and knowledge generation in the small livestock sub-sector.

6.4 Enabling environment analysis

Legal and institutional framework

Generally, for agriculture innovation systems to be strong and effective, there is a strong need to have in place a conducive enabling environment. In this regard, there is a need for supportive legal and institutional framework, laws, rules and regulations, clear policies and governance mechanisms that stimulate new ways of working, new processes, new products as well as new forms of organization.

The AIS assessment found that there exist institutions, policies and other instruments that promote AIS such as the Vision 2050, the National Strategy for Transformation (NST1), the National Agriculture Policy, the Fourth National Strategy for Agriculture Transformation (PSTA4), the National Land Use and Development Master Plan, Rwanda Financial Sector Development Program II, the National Policy on Science, Technology and Innovation, and Rwanda Livestock Mater Plan, among others. These policy instruments strongly influence the small livestock sub-sector in the following ways:

- The policies support the contribution of the small livestock to farm income, resilience, and enhanced nutritional status of farming families.
- Substitution of chicken and pork meat for domestic red meat consumption would also reduce domestic meat prices and enable an increase in meat export while increasing protein consumption among poor households.
- Availability of sufficient animal feed is a crucial element in promoting livestock development Rwanda.
- Incentivizing the private sector investment in animal feed processing for small livestock.

- Enhance the capacity of the veterinary services for disease surveillance, vaccination, diagnostic capacity, and early warning and rapid response.
- Support community breeding practices and animal selection to improve animal genotype.
- Strengthen artificial insemination (AI) in livestock by capacity building of farmers, community animal health workers, and extension workers.
- There is a need for an integrated approach to increase availability and quality of animal feeds at household and national levels.
- Promote processing of animal products and the quality assurance.

The political stability of the country is to see every citizen in the mirror of growth and development. The country has also established infrastructures related to good road networks and feeder roads in rural remote areas. The business promotion, good-will of the government in the course of trade policy reformation, internet connectivity and broad-band platforms shows potential for future growth of the agriculture sector.

The AIS assessment showed hindrances related to:

- People's mindset, resistance to change in relation to their perceived minds that eating eggs and chicken is for rich people. Also, the adoption of new innovations sometimes requires long processes as some rural people need more sensitization, mobilization and awareness to change their mindset.
- Low capacities such as lack of knowledge and technical and soft skills, limited capacity building and awareness raising.
- Lack of financial means for the development of the agricultural innovation, especially for remote rural farmers living in extreme poverty levels.

Climate change and extreme weather events

Rwanda has experienced a growing number of natural and man-made disaster risks which include volcanic eruptions, earthquakes, drought, floods, landslides, fire, various storms (e.g. windstorms, lightning, rainstorms, and thunderstorms), accidents, technological and industrial hazards and animal epidemics. The frequency and intensity of disaster risks have been increasing, in light of climate change, population growth, urbanisation, and environmental degradation.

These hazards and disaster risks disrupt people's livelihoods and endanger human and livestock as well as food security. In addition, they cause large-scale physical and environmental damages, interruption of economic activities as well as socio-economic retardation. The disaster risks also increase the poverty of rural and urban households and

erode the ability of the national economy to invest in key social sectors which are important to reducing poverty and increase economic growth.

Priority areas for strengthening the enabling environment

To strengthen the enabling environment for the small livestock sub-sector in Rwanda, there should be an empowerment of research for increasing productivity, improving animal health, processing and value addition of animal products with required standards and promotion of local animal feed industries.

7. Discussion and synthesis of the results

7.1 Consolidated analysis of challenges and constraints

Analysing results across the three case studies gave a general picture of challenges and constraints that negatively affect the innovation system in the small livestock sub-sector in Rwanda (Table 4).

Table 4: Identified challenges and constraints

Challenges and constraint	Findings
1. Limited coordination among organizations involved in small livestock.	• Farmer cooperatives have limited organizational capacity to access resources and funding and participate effectively in value chains.
2. Animal health issues causing reduced production and mortality in small livestock.	• There is a shortage of veterinary officers to provide timely services, in particular in remote rural areas. • Diseases affecting pig production in Rwanda include African swine fever, Influenza A virus in swine (IAV-S), Pseudorabies*, Swine dysentery, Swine erysipelas*, etc. • In poultry, disease attacks include Avian influenza, Coccidiosis, Fowl pox, infectious bronchitis, Newcastle disease, Salmonellosis, etc. • Recent increased mortality rates especially among piglets of one to two months. • Limited use of evidence-based research to inform decisions, advisory services and policy making processes. • Poultry farming agents have limited technical capacities to take care of/treatment of day-old chicks. • In poultry production, farmers buy medicine without knowledge of the appropriate medicine to use, or have unpredictable access to medicine, leading to high mortality rates in chicken.

Challenges and constraint	Findings
3. Transport and logistics issues for live animals, products to markets and advisory service staff.	• Limited number of refrigerated trucks for transportation of pork available. • Lack of transportation facilities for artificial insemination staff. • The Sasso agents put chicken into wooden boxes and ride bicycles for distribution, with some mortality during long rides.
4. Financial constraints for investing in small livestock farming and business.	• Demand for financing in the small livestock sub-sector exceeds available budget. • High interest rates at commercial banks and other finance institutions. • Limited access to start-up capital for farmers in remote areas who want to participate in poultry farming. • Households without collateral security for bank loans are particularly vulnerable. • Farmers expressed the view that there should be specific provisions of funding and support for small holder farmers. • Smallholder farmers often lack insurance coverage.
5. Poorly developed value chains and markets.	• The business environment in the small livestock sector is largely informal, which limits investments and resource mobilization. • Low education level negatively affects livestock farming. • Distant markets limits farmers' participating in different levels of small livestock farming. • Low competition of local products in regional markets due to high production costs and quality issues. • Poor understanding at local level of commercialization, and weak market orientation. • Low consumption of chicken meat and eggs in the country (on average one person in Rwanda eats one egg per month and 1.2 Kg of chicken meat in a year). • Lack of marketing and negotiation skills for individual small holder farmers involved in the chicken piggery value chains. • The COVID-19 pandemic affected markets during lockdowns and movement restrictions.
6. Availability and access to animal feeds is limited or irregular.	• A small size of land per capita implies that the small livestock sub-sector is affected in both rural and urban settings (animal feed production). • Lack of animal feeds plants or shops in some areas. • Shortage of land is a major concern for feed industry production in remote rural areas.

Challenges and constraint	Findings
	• Issues regarding inputs for animal feed industry: demand outstrips domestic supply, and imported inputs are expensive. • Timely access to animal feeds in remote areas, and high transport costs in delivery of animal feed. • Having the right feed for the right animal, e.g. feed formulation for small piglets.
7. Weak technical and functional capacities among smallholder farmers.	• Limited organisational capacity in farmer organizations and among innovation system actors. • Limited poultry and piggery farming skills among smallholder farmers especially in remote rural areas. • Lack of marketing and negotiation skills among smallholder farmers involved in small livestock value chains. • Poverty and low education level of rural smallholder farmers limits their capacity for innovation.
8. Culture and tradition limits household consumption of small livestock protein.	• Mind-set of people who think that eating eggs or chicken is for rich people.
9. Dishonest actors.	• Some people pretend to be an agent of Uzima Chicken Ltd trying to sell broilers in the name of Sasso breed in remote areas.

While not specific to the small livestock sector, two external factors also posed challenges:

- The Covid-19 affected distribution of live animals, feeds and meat due to movement restrictions and total lockdowns in the country, and reduced demand from the hospitality sector.
- Rwanda faces different natural and man-made hazards, including extreme weather events, such as floods, landslides, strong winds and thunderstorms that can kill animals, reduce harvests and damage related infrastructure.

7.2 Enabling factors and opportunities

The consolidated analysis of enabling factors, strengths and opportunities in the AIS for the small livestock sector identified the following key factors (Table 5).

Table 5: Enabling factors and opportunities

Enabling factors and opportunities	Findings
1. Political will and institutional frameworks to support agricultural innovation.	• Presence of strong institutional framework, conducive policy environment and political will for the agriculture sector. • The government has put in place a strong institutional framework: MINAGRI, RAB, University of Rwanda (CAVM), Private Sector Federation. • Favorable legal and policy context on agriculture innovation systems, including the small livestock sub-sector: existing policies, strategies, laws and regulations, various government programmes, etc. • Policy to engage farmers in investments and promoting trade and value chains, in pursuit of poverty alleviation. • Land consolidation policy. • Good governance and leadership. • Peace and security in Rwanda.
2. Innovation fit local context and climatic/weather conditions, and match farmers' needs.	• Distribution and payment models adapted to farmers' needs, such as use of agents, and of online payments and orders. • Small livestock can be raised on relatively small plots of land. • Fertile soils and good climatic conditions for growing raw materials and crops. • Use of improved breeds that increase productivity in local farming conditions. • Community engagement and awareness creation included in interventions. • Gorilla Feed Ltd. has put in place the "Grow Together" model to involve rural farmers in the entire process. • Sasso breed is resistant to diseases, raised in back-yards and can feed together with traditional chicken.
3. Capacity of farmers, and extension and advisory services.	• Availability of veterinary and agronomist officers at district and sector levels, with capacities to provide technical support and capacity development to farmers. • MINAGRI and RAB support farmers via Districts including budget, equipment, training and capacity building and technical guidelines.

Enabling factors and opportunities	Findings
	• Also non-government actors provide advisory services to farmers, e.g. distribution agents of Uzima chicken Ltd. • Farmers are willing to adopt new technologies in poultry farming in terms of feeding, vaccination and improved genetics. • Farmers in the small livestock sub-sector and feed industry include entrepreneurs with higher education. • Through land consolidation, small-holder farmers are able to increase productivity in e.g. maize, wheat, rice and other inputs for the animal feed industry.
4. Capacity regarding animal health and veterinary services.	• Availability of veterinary services and well-trained veterinaries and agronomist. • Sector agronomists and veterinary officers provide training for small-holder farmers to identify sick chicken (weight loss, loss of feathers, abdominal discharges and general weakness or inactiveness).
5. Infrastructure for ICT, transport and meat processing.	• Rural-urban linkages through road networks, including feeder roads, for transportation of goods and provision of services in general (chicken, eggs, vaccines and feeds). • The use of ICT in the agriculture sector for e-payment, e-banking, use of smart-phones for easy communication at all levels, and for information sharing. • Existence of a modern piggery slaughter house (owned by CPPA).
6. Favourable fiscal policies.	• The GoR has exempted Value Added Tax (VAT) on animal feeds, inputs for feed production and other agricultural products. • Existing subsidies for the agriculture sector in terms of fertilizer (smart *Nkunganire*).
7. Market availability within and outside Rwanda.	• Market opportunities exist within and outside the country: demand is high and increasing for eggs and chicken meat and pork in Rwanda and Democratic Republic of Congo (DRC). • Small livestock farming, and collective action in women's groups has improved income and welfare in rural areas. • Value addition and processing of pork in the country (*Akabenzi*, sausage and *Jambo* production).

Enabling factors and opportunities	Findings
	• Training in combination with offering start-up capital after training helped trainees to start their own farm/business (CPPA).
8. Public-private partnership.	• The GOR has invested in private facilities for piggery research and artificial insemination. • Through PPP, a national hatchery was made available to Uzima Chicken Ltd.
9. Successful interventions emphasise strong communication and coordination.	• Collaboration between agents, local distributors and district coordinators for distribution of chicken in remote rural areas as well as in urban centres. • Distribution of improved breeds of pigs. • Piglet distribution chain among women and youth, coordinated by CPPA, and includes monitoring by CPPA representatives. • Good relationships and collaboration between Gorilla Feed Co. Ltd. and farmers and distributors of feed.
10. Presence of national and regional institutions.	• Regional integration and collaboration on agriculture and trade (EAC, AU, etc.). • On-going livestock initiatives at University of Rwanda, higher learning institutes, and research organizations.
11. Employment and entrepreneurship in small livestock value chains.	• Creation of employment opportunities for youth and women engaged in the distribution of Sasso chicks, vaccines, medicines in various districts (over 400 youth's agents). • Improved income from small livestock for small-farmers, especially among youth and women.
12. Resource mobilization for the small livestock sub-sector	• Presence of donors, funding agents and government ministries with interest in the small livestock sub-sector.

7.3 Discussion of results at systems level

An AIS approach is instrumental in ensuring that both existing and new knowledge will be used more effectively for the livelihoods of the rural poor. Agricultural innovation systems require different sets of actors with improved communication, information exchange, interaction and networking through communication channels that enable the acquisition of new ideas and knowledge from various sources. It is therefore imperative to identify ways for this kind of knowledge to be brought into the change process. In brief, the innovation systems approach must recognize the importance of technology with increased focus on innovation that widens the range of actors involved.

Generally, in the government agricultural programmes and strategies, small livestock is currently among the top priorities. With reference to the Livestock Master Plan developed by the Government of Rwanda in collaboration with FAO, the main focuses were put on production systems that can quickly reach as many people as possible and have a socio-economic impact at household level. The Government of Rwanda and key stakeholders through various functions have invested a lot of efforts to bridge the gaps in the coordination within the small livestock sub-sector.

The results from the AIS assessment within the small livestock sub-sector showed that different functions are performed. However, some AIS functions still need to be improved such as the capacity building, technical support services, financing and resources mobilization. Many actors still face challenges regarding the continuous learning and improvement of their knowledge, skills and practices, especially for marking and networking capacities.

The findings above are in confirmation with what Shahbaz and Boz (2020) expressed, that the system of small livestock and mixed crop-livestock systems seem to be difficult and diverse because of the weaknesses of national agriculture research in developing countries in the sector of livestock than crops. There are various conditions which make the small livestock sub-sector weak in developing countries like asymmetric information about animal health and breeding which remains underinvested and often underdeveloped (Faisal et al., 2020). This is one of the major challenges of this sector that hinders the private participation in terms of investment and other factors which may enhance the development of this sector. Therefore, to handle the above challenge in the small livestock sub-sector, the starting point for getting the information and innovation is to facilitate the livestock system actors to get access and to innovate through partnering, organizing and linking in different ways.

AIS findings showed that there is a great potential for agricultural innovation to increase farmer incomes, improve food and nutrition security and allow for sustainable management of natural resources. Indeed, farmers are willing and able to innovate through adoption of improved practices and technologies in livestock breeding, management and value chain development. The government has recognized that animal resources have critical contributions in different ways that affect the life of country like contribution to national GDP, poverty reduction, boosting export earnings and ensuring nutritional security. Small livestock plays a critical role in providing assets and increasing income in rural households living below the poverty line. For instance, through the distribution of piggeries to the local farmers by CPPA in Kisaro, and other programmes which enhance various small livestock and other animals. These home-grown solutions programmes have facilitated and provided food security and increased consumption of pork, eggs and chicken meat for households living in poverty, especially in female-headed households.

From the three analysed case studies, it was noted that youth and women play a major role as agents for Uzima chicken Limited and Gorilla Feeds industry by distributing chicken birds and feeds to rural remote households. They are recognized as the drivers of agricultural innovation in Rwanda. Initially, it was perceived by rural residents that eating eggs, pork and chicken meat is meant for rick people. However, the mindset is now changing due to awareness campaigns by these agents to fight malnutrition that was always common in rural areas.

The AIS analysis revealed that government agencies such as MINAGRI, RAB, NAEB, NIRDA, MINICOM and others are the biggest providers of services related to the small livestock sub-sector. They mainly focus on information sharing, technical advice and institutional support, while access to resources and other capacities are mostly addressed by the private sector.

8. Conclusions and recommendations

8.1 Recommendations to strengthen innovation in the small livestock sector

Results indicated that all the systemic capacity domains of AIS are existent and fairly well developed, but that they can be enhanced further. The future capacity development strategies for such capacity development will be developed jointly with the stakeholders. In realization of this, capacity building of various institutions to respond to their vision, missions and mandate in developing the small livestock sub-sector will be enhanced.

In order to address the highlighted challenges in the agriculture sector in Rwanda, innovation that involves and benefits family farmers and small and medium enterprises are very essential. This need to be supported by capacity development in the AIS, including development of functional capacities, or soft skills among actors at all levels. Rwanda has started to embrace AIS approaches and has set up an Agricultural Sector Working Group to spearhead innovation in the sector. Therefore, the country needs to enhance the development of the functional capacities for innovation through TAP-FAO project as well as other different initiatives and programmes at both local and national levels and related to small livestock sub-sector.

The outputs from the current AIS assessment should be further utilized to serve as evidences in informing policies and decision makers, and key actors and beneficiaries in order to boost the agricultural innovation capacities for in Rwanda as far as the small livestock is concerned. The AIS Assessment in Rwanda recommends the following:

Collaboration and coordination

1. **Empower and strengthen the National Platform on small livestock in Rwanda**. The responsibility for small livestock is fragmented across different organizations, creating coordination challenges. A national platform has been formed to provide such

coordination, but needs to become more active. To realize this, there should be improvement in coordination, dialogue and interaction among key stakeholders about best practices to enhance agricultural innovations, to create linkages among all actors' network from both the public and private who play a major role at different nodes.

Capacity development

2. Ensure continuous learning and improvement of actor's knowledge, soft skills and practices for marketing and networking capacities.
3. The Government of Rwanda through MINAGRI should mainstream soft skills in all its strategic plans in order to guarantee the sustainability of innovations in the small livestock sub-sector.
4. Advisory services should put more efforts into strengthening capacities of farmers and cooperatives in small livestock management and related business skills.

Policy

5. Mainstreaming of agricultural innovations across all policies, strategies and programmes that promote the small livestock sub-sector especially animal health/veterinary services, animal feeds as well as transport facilities for live animals and meat.
6. Strengthening funding mechanisms that support small holder farmers' access to affordable finance particularly those living in rural remote areas to create a conducive working environment for vulnerable people.
7. Enhancing investment promotions in research and development to support innovations in the small livestock sub-sector.
8. Government and financial institutions should improve farmer's access to agricultural insurance, thereby reducing risks. This can be one through education and community awareness creation.
9. The Government of Rwanda through MINAGRI should put in place a strong monitoring framework to follow up on the implementation of the AIS recommendations for the small livestock sub-sector.

8.1 Priorities for TAP-AIS project's capacity development phase

Policy dialogue

The Policy-level capacity development under the TAP-AIS needs to be tailored to existing policy context. In view of this, the AIS assessment has highlighted the current situation in terms of agricultural innovation systems for the small livestock in Rwanda. To this end:

- Policy dialogues need to be further organized to influence the innovation policy-making processes.
- The responsible institutions should develop more innovative policies and support policy and decision-making processes in order to foster the innovation agenda.

- The TAP-AIS policy dialogue should serve as an opportunity to identify potential and relevant enabling organizations and engagement in policy or high-level institutional dialogue.
- The policy dialogue should be used to inform decision-makers, to be able to lobby; draft policy briefs and to establish new regulations/policy strategies to reinforce the agricultural innovations.
- The agriculture sector working group and the national platform for livestock sub-sector will be instrumental to bring changes and new ways of working at all levels.
- Through multi-stakeholder engagement, all actors involved in the small livestock sub-sector should be brought on board to operationalize the TAP framework at the national and regional levels.
- Deliberative fora should be organized comprised of high profile stakeholders, to be part of the policy dialogue platform.
- All stakeholders have to be engaged in the policy dialogue process, and develop related skills. Particularly, small holder farmers need to be facilitated and guided to get involved and participate in the policy dialogue.

Capacity development of key organizations

The overall objective of AIS assessment was to take stock of agricultural innovation systems and provide insights on factors that influence the capacity to enable, foster and promote inclusive and responsible innovations; identifying critical gaps, needs, opportunities as well as good practices.

In this respect, the continuous learning of actors and improvement of their skills, knowledge and practices was found necessary in consideration of the systemic capacity development. Coordination issues identified through the entire AIS assessment require a range of technical, structural and policy interventions. The findings showed that the enabling environment is strong. Yet, there are issues and challenges that seem to be technical and structural overcoming them requires certain capacity development interventions.

Cognizant of the role of agriculture in the Rwanda economic development, there is a need to put more focus on innovations for marketing and networking capacities to be able to adopt the culture of doing things differently. This becomes a key responsibility as it will have to be mainstreamed across other development sectors. Therefore, the AIS assessment of the small livestock sub-sector highlighted the key challenges that if addressed, the sector will be more productive.

In addition, capacity development under the TAP-AIS project should focus on developing new capacities and incentivize actors, and empower them to initiate more agricultural innovations. Therefore, based on the AIS results, it is ascertained that capacity development interventions will address the identified key issues to enhance the agriculture innovation processes in Rwanda. Based on the current AIS Assessment findings, at one way or another,

the following three organizations are recommended to take part into the TAP-AIS project's capacity development:

- National platform on the small livestock in Rwanda,
- Uzima Chicken Limited.
- Centre de Perfectionnement et de la Promotion Agricole (CPPA Kisaro).

However, for a systemic capacity development, two additional AIS platforms were recommended by stakeholders during the AIS assessment findings validation workshop:

- Rwanda Pig Farmers Association (RPFA).
- Rwanda Poultry Industry Association (RPIA).

Overall, the actual capacity development process, should seek opportunities to involve other key stakeholders or actors in pursuit of training and capacity development programmes.

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Annexes

Annex 1: AIS assessment team and roles in the AIS

IPAR Professional Staff/Researchers				
Name of Staff	**Researcher**	**Area of Expertise**	**Position Assigned in the AIS Assessment**	**Role in the AIS assessment**
Alexandre Simons, PhD	IPAR	Development Economist	Quality Assurance	- Review Report writing - Oversee the design of the analytical framework - Quality Assurance - Research ethics
Jean Baptiste Nsengiyumva, PhD	IPAR	Environment and Natural Resources Management	Project Leader (Lead Researcher)	- Overall Supervision - Project management - Design and monitor the implementation plan - Design of the analytical framework - Data Analysis - Report writing and Dissemination
Mr. Evariste Gahima	IPAR	Business Administration and Education	Researcher and Field Coordinator	- Desk review of existing studies (literature review) - Design the data collection tools (FDGs, KIIs) - Quality assurance of collected data - Lead qualitative Analysis
Mr. Anthony Baguma	IPAR	Development Economics	Field coordinator	- Schedule fieldwork, - Overseeing field logistics, - Plan & Coordinate FDGs and KIIs, - Communicate with Researchers, - Support the research team in fieldwork write ups, - Manage Research assistants (enumerators).

Mr. Ronald Singoma **Mr. Sam Tumusiime** **Mrs. Doreen Mukabalisa** **Ms. Doreen Kayiraba** **Mr. Godfrey Niwagaba** **Mr. Frank Karengera**	**IPAR**	-	Research Assistants	- AIS Trained Research Assistants - Fieldwork/Data Collection - Write ups of Primary Data (KIIS &FGDs)

Annex 2: Data collection Tools/Questionnaires

I. Case Studies/IBIZIGWAHO:

1. The poultry case study: Saso breed by Uzima chicken with focus of the case study on small-scale farmers, not large-scale commercial production/*Ubworozi bw'inkoko za Saso bukorwa na Uzima Chicken, hibandwa ku borozi bacirirtse/aborozi bo mu ngo*

2. Piggery/Artificial insemination: Genetic improvement of pigs (Case of Kisaro farming)/*Ubworozi bw'ingurube, kuzitera intanga hongerwa umusaruro wazo- Ku Kisaro mu Karere ka Gicumbi*

3. Piggery/animal feed: This case study is cross-cutting and results have implications also for animal production in other species, (Case of Gorilla animal feed industry)/*Gutunganya ibiribwa by'amatungo bigaburirwa ingurube n'andi matungo, hibandwa k'uruganda rwa Gorilla*

II. Data Collection-Guiding Questions (KIIS/FGDS/Meeting-workshop discussions: *Urutonde rw'ibibazo byifashishwa mu gushaka amakuru ajyanye n'ubworozi bw'amatungo magufi*

STEP ONE: How does innovation actually happen? / Ese impinduka mu mikorere zigenda gute?? Zikorwa gute??

i. Functional Analysis (through case studies)

Introduction of the project (AIS) and objectives of the study/ *Gusobanura icyo ubushakashatsi bugamije mbere yo gutangira kubaza*
We are trying to understand the innovation process of this case study, by asking key respondents what actually happens in this innovation. Missing/Gaps, opportunities: *Ubu bushakashatsi bugamije kumva impinduka mu mikorere ijyanye n'ibyo mukora mu bijyanye n'ubworozi bw'amatungo magufi. Kumva imbogamizi muhura nazo, ibigenda neza n'ibitagenda neza.*

1. What are the main functional roles and activities done here? Ese ni izihe nshingano n'ibikorwa bikorerwa hano??

2. How long have you been involved in the xxx (e.g Kisaro farming) and what's your current role in the initiative? *Umaze igihe kingana iki ukora aka kazi? Ese Mwatubwira ibyo mushinzwe gukora muri aka kazi kanyu??*

3. In your opinion, describe the innovation that you have here?, what is new and exciting here? *To be specific on the innovations/activities and how this this takes place (List all of*

the process and procedures). Ukurikije uko ubyumva, watubwira udushya mufite mu mikorere yanyu hano? Ni ibihe mukora mu buryo budasanzwe? Ni uwuhe mwihariko?

4. What has actually has happened in the innovation process? How it happened and why, and who was involved? And what is the timeline for this innovation to happen?? *Mwatubwira uko byagenze ngo mugere ku mikorere idasanzwe/guhanga udushya mu ijyanye n'ibyo mukora? Ese byagenze gute? Byatewe n'iki? Ni bande babigiramo uruhare? Ese Mwatubwira igihe byatwaye kugira ngo mubigereho??*

5. How do farmers/value chain actors actually respond to and participate in the innovation process, and how this has changed over time. What are the specific platforms through which this is done? These questions may also pick up issues regarding the scaling up and adoption of the innovation/ *Ni gute abahinzi cg abandi bari mu iki gikorwa bigira uruhare/bitabira ibijyanye n'udusha mwahanze? Ese ni izihe mpinduka mwagiye muhura nazo (positive or negative)?? Ibi bibazo bishobora kugufasha kumenya andi makuru ajyanye n'uko udushya twagiye dukwirakwira/twagurwa ndetse n'uburyo utwo dushya twashyizwe mubikorwa.*

6. <u>How are the farmers and the community members benefiting from the innovation (the case study in question)? Ni izihe nyungu aborozi n'abaturage muri rusange bavana mu bikorwa byanyu/ ibyo mukora mu guhanga udushya?</u>

7. What will happen next? What are your key challenges, strengths and opportunities, going forward? *What are your plans? Ese murateganya gukora iki? Ese mubona hari ubuhe bushobozi/imbaraga mufite? izihe imbogamizi? n'amahirwe mufite yo kubigeraho mu gihe kizaza? Mufite iyihe gahunda??*

<u>STEP TWO: UNDERLYING CAUSES/WHY FUNCTIONS PERFORM WELL OR NOT??</u>

ii. <u>Structural Analysis</u>

1. Who are the main/ key stakeholders (private or public) in the activities/processes and innovations mentioned above? *Mwatubwira abafatanyabikorwa b'ingenzi mu bikorwa byose mwatubwiye haruguru??*

2. What are the roles and responsibilities of each actor? Who does what? What are the more influential roles? What is the linkage, network towards innovation? *What are the links? Mwatubwira inshingano n'uruhare rwa buri wese? Ese bakorana bate muri i?*

<u>Instructions</u>*:*

Probe for which organization has more influence/power/ interest? Systemic Structural Analysis deals with the top organisations that are in that given field; the experts, the overall know how of the system works. Organizational structural analysis deals with individual

organisations. (This has to be focused on while collecting data). *Genda ubaza abafatanyabikorwa bafite ubushobozi kurusha abandi, avuga bikumvikana neza kurusha abandi, n'abafite inyungu cyane kurusha abandi. Zirikana ko systemic structural analysis (deals with top organizations in that given field) itandukanye Na organizational structural analysis (dealing with individual organisations).*

iii. Capacity Analysis

1. What are the strengths, weaknesses, opportunities and threats that the organizations have (SWOT Analysis)? / *Mwatubwira ubushobozi, intege nke, amahirwe n'imbogamizi mufite cg muhura nazo mu mikorere yanyu??*

2. Are there any aspects that were put in place that would have led to innovation? What is lacking? *Ese haba hari ibyagendeweho kugira ngo mugere ku mikorere idasanzwe/ihanga udushya? Mubona habura iki?*

3. What technical and soft skills do you have in order to achieve this? What things do you lack /hindrances in order to accomplish certain successes? With focus on inhibitors in terms of access, knowledge transfer, in terms of credits to those joining these businesses and the technical know-how? *Ese ni ubuhe bumenyi bwihariye mwaba mufite kugira ngo mubigereho? Ese mubona habura iki kugira ngo bigerweho neza uko byakagombye/hibandwa mu ku buryo bwo kubigeraho, gutanga ubumenyi cg ubushobozi ku bashaka kwinjira mu byo mukora?*

Note: Capacity Analysis/Capacity Gap Assessment tool in excel format will be also used/ Ku bijyanye na Capacity Gap analysis azakoreshwa n'ibibazo biri muri excel sheet bu bantu bazaba batoranijwe mu bigo bitandukanye bakora ku bijyanye n'ubworozi bw'amatungo magufi.

Enabling environment/policy environment

Questions regarding enabling and hindering factors and conditions encountered in the innovation process: (E.g. regarding the structure of the network of organisations involved, the overall technical capacity and 'soft skills' of the actors, and in the external environment (e.g policy, infrastructure, and culture). Some of these may have been overcome as the innovation process has moved from one step to next. Others are more persistent:

1. What incentives are put in place to encourage those that want to enter this sector? What motivates you to keep operating in this sector? / *Ni ibi bihe mubona bishobora gukurura abashaka kwinjira mu byo mukora? Ese mwebwe ni ibihe bibatera imbaraga zo gukomeza gukora ibingibi?*

2. Tell us about the enabling environment/enablers and disablers (guidelines, strategies, rules, regulations, political will, governance and leadership, policies, infrastructure, culture etc.) to facilitate operation and or implementation of works in this sub-sector?

Mwatubwira Ibintu byose bibafasha gukora ibikorwa byanyu neza n'ibituma mudakora neza (Amategeko n'amabwiriza biriho, ingamba za leta, ubushake bwa politike, ibikorwa remezo, ibijyanye n'umuco, imiyoborere etc)?

Murakoze/Thank you!

Annex 3: List of key informants for the capacity gap analysis

TAP-AIS project: capacity gap analysis					
List of Experts: Rwanda					
Expert #	**Name**	**Gender M/F**	**Organisation**	**Email/ Contact information**	**Date of Interview**
1	Betty Mukandoli	F	NGO: Uzima Chicken Ltd/Administration and operations manager	info@uzimachicken.com or Tel: 788751882	06/05/2021
2	Celestin Myambi Barahenda	M	NGO: Enabel-Belgian Cooperation	celestin.myambi@enabel.be	05/05/2021
3	Kabandana Gauthor Savio	M	DELIGHT AFRICA	gs.kiphagro.net	01/05/2021
4	Vincent Nsabuwera	M	Enabel	vincent.nsabuwera@enabel.be	01/05/2021
5	Eric Musizana	M	Access to Finance Rwanda (AFR))	musizana@afr.rw	01/05/2021
6	Nkusi Bukeye Eric	M	Rwanda Development Bank/BRD	e.nkusi@brd.rw	02/05/2021
7	Marc Schut	M	CGIAR	m.schut@cgia.org	02/05/2021
8	NSHIMIYIMANA Alphonse Marie	M		namumc@yahoo.fr	01/05/2021
9	Dr. Fabrice Ndayisenga	M	Rwanda Agriculture Board/RAB	fabrice.ndayisenga@rab.gov.rw	30/04/2021
10	Dr. Ngarambe Rutera Michel	M	Rwanda Agriculture Board/RAB-SPIU	ngarambemic2000@yahoo.fr, michel.ngarambe@rab.gov.rw	03/05/2021
11	Dr. Kasim Munyegera	M	IPAR-Rwanda	kasimgm@gmail.com	30/04/2021
12	Hyacenthus UWITONZE	M		usecethi@gmail.com, 0788218372	02/05/2021
13	JONAS MUNYURANGABO	M	Ministry of Trade and Industry (MINICOM)	jmunyurangabo@minicom.gov.rw	30/04/2021
14	Dr. Martin Ntawubizi	M	University of Rwanda (UR)	martin.ntawubizi@gmail.com, m.ntawubizi@ur.ac.rw	29/04/2021
15	Dr. Solange Uwituze	F	Rwanda Agriculture Board/DDG	solange.uwituze@rab.gov.rw	30/04/2021
16	Dr. RUTAGWENDA Theogene	M	The Ministry of Agriculture and Animal Resources (MINAGRI) the director General in charge of Animal Resource Development	rutagwendat2006@gmail.com	28/04/2021
17	RUSHIGAJIKI DIDACE	M	The Ministry of Agriculture and Animal Resources (MINAGRI)	rushigajiki@minagri.gov.rw	27/04/2021
18	Dr Olivier KAMANA	M	NIRDA-Rwanda	olivier.kamana@nirda.gov.rw	29/04/2021
19	GAHIRE Pascal	M	SAED Project/SNV	gahire@gmail.com	30/04/2021

20	Hyacenthus UWITONZE	M	BUGESERA VETERINARY	usecethi@gmail.com, 0788218372	04/05/2021
21	NSHIMIYIMANA Alphonse Marie	M	RWANDA COUNCIL OF VETERINARY DOCTORS (RCVD)	namumc@yahoo.fr	05/05/2021
22	Florence MUJAWIMANA	F	MINAGRI- National Project Coordinator	florence.minagri@gmail.com	27/04/2021

Anne 4: Introductory letter for data collection

Food and Agriculture Organization of the United Nations

UNITED NATIONS RWANDA

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024/2021, AIS

25th March 2021

Mr, Ms., Mrs., Dr. .....

Subject: FAO assessment of agricultural innovation systems

This is to kindly request your organization's participation in an **assessment of the agricultural innovation system (AIS) of the small livestock sub-sector** in Rwanda, which the Institute of Policy Analysis and Research (IPAR) is carrying out in 2021 under a Letter of Agreement with FAO-Rwanda.

The study is part of the global project '*Developing capacities in agricultural innovation systems: scaling up the Tropical Agriculture Platform Framework*', funded by the EU under its DeSIRA initiative during 2019 - 2024 and operating in nine countries. In Rwanda, FAO is partnering with the Ministry of Agriculture and Animal Resources (MINAGRI) in implementing the project.

The work of IPAR will describe the AIS of the small livestock sub-sector in Rwanda in terms of key functions, underlying causes of its performance, and opportunities for improvement. It will provide recommendations, priorities and entry points for strengthening capacities for innovation of the small livestock sub-sector in Rwanda, with focus on key organizations and the policy level.

Your kind assistance towards the assessment is highly appreciated,

Yours sincerely,

Gualbert Gbehounou
FAO Representative

The TAP-AIS project

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MORE INFORMATION
http://www.fao.org/in-action/tropical-agriculture-platform
http://www.fao.org/in-action/tap-ais/en
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