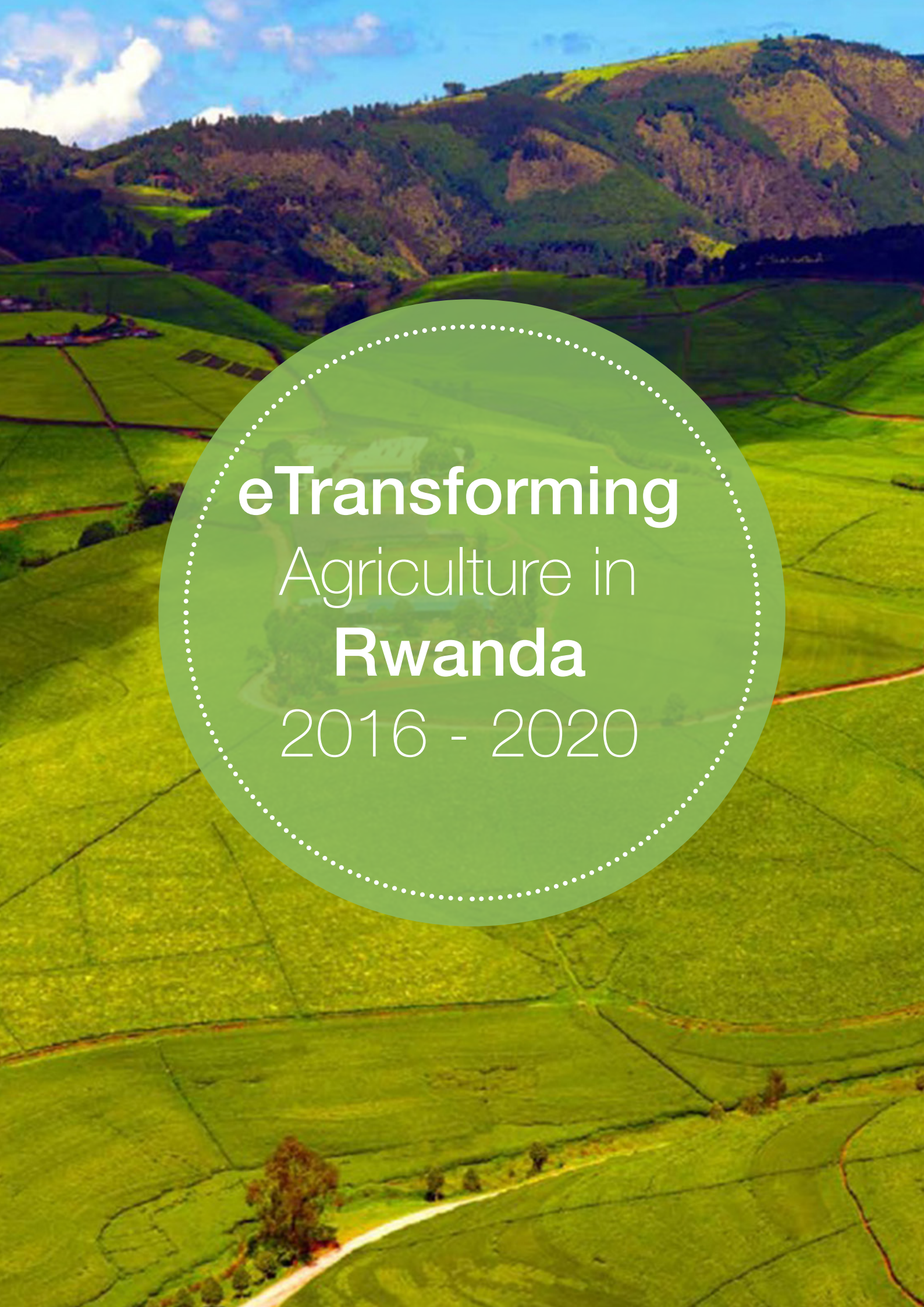
National **ICT4RAg** Strategy (2016 -2020)

Republic of Rwanda

Ministry of Agriculture
and Animal Resources

Acknowledgement

The development of the ICT for Rwanda Agriculture (ICT4RAg) Strategy is a combined effort of a number of stakeholders under the guidance and sponsorship of the Ministry of Agriculture and Animal Resources (MINAGRI). A taskforce from MINAGRI, Ministry of Youth and ICT (MYICT), Rwanda Agricultural Board (RAB), National Agricultural Export Board (NAEB), Rwanda Development Board (RDB) and the Private Sector Federation – ICT Chamber (PSF/ICT) provided further valuable contribution and insights towards the development of the strategy. The Ministry of Agriculture and Animal Resources extends its sincere gratitude and appreciation to all those involved in the development of the ICT4RAg Strategy.



eTransforming Agriculture in Rwanda 2016 - 2020

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List of Abbreviations and Acronyms

AMIS	Agricultural Management Information System
APP	Application
ASWG	Agriculture Sector Working Group
BDF	Business Development Fund
CCI	Community Innovation Center
CICA	Agricultural information and Communication Centre
CIP	Crop Intensification Program
DOQ	Digital Orthophoto Quadrangle
DTWMS	Document Tracking and Workflow Management System
E- SOKO	electronic Soko (Market information & Communication service for agricultural markets)
EAX	East Africa Commodity Exchange
EDPRS	Economic Development and Poverty Reduction Strategy
eGirinka	Electronic Girinka (One Cow per Poor Family Program)
EICV	Integrated Household Living Conditions Survey
EU	European Union
FBLAB	Fabrication Lab
GDP	Gross Domestic Product
GIS	Geographic Information System
GoR	Government of Rwanda
GPS	Global Positioning System
HR	Human Resources
ICT	Information & Communication Technology
ICT4D	Information & Communication Technology for Development
ICT4RAg	Information & Communication Technology for Rwanda Agriculture
ID	Identification
IICD	International Institute for Communication and Development
ISP	Internet Service Provider
IT	Information technology
IVR	Integrated Voice Response
KH	Knowledge Hub
Klab	Knowledge Lab
KMS	Knowledge Management System
LAN	Local Area Network
M&E	Monitoring and Evaluation
MDG	Millennium Development Goal
MINAGRI	Ministry of Agriculture and Animal Resources
MINICOM	Ministry of Trade & Industry
MINECOFIN	Ministry of Finance & Economic Planning
MINIRENA	Ministry of Natural Resources
MYICT	Ministry of Youth and ICT
NAEB	National Agricultural Export Board
NICI	National Information and Communication Infrastructure
PHHS	Post-Harvest, Handling and Storage
PPP	Public-Private Partnership
PSF	Private Sector Federation
RAB	Rwanda Agricultural Board
RALIS	Rwanda Agricultural and Livestock Inspection and Certification Services
RCA	Rwanda Cooperative Agency
RDB	Rwanda Development Board
REMA	Rwanda Environment Management Authority
RFID	Radio Frequency Identification
RSB	Rwanda Standards Board
RURA	Rwanda Utilities Regulatory Authority
SAP	Service Access Point
SMS	Short Message Service
SPAT	Strategic Plan for Agricultural Transformation
SPIU	Single Project Implementation Unit
SRMP	Smart Rwanda Master Plan
SWOT	Strength, Weakness, Opportunity and Threats
TV	Television
USB	Universal Serial Bus

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Foreword

The Ministry of Agriculture and Animal Resources has recognized the importance of better coordination and appropriate solutions regarding the use of Information and Communication Technologies (ICTs) for sustainable agriculture and rural development. This recognition has led to the development of a holistic national ICT strategy for Rwanda Agriculture (ICT4RAg) that offers critical support to rationalize and optimize financial, human and institutional resources and harness ICT4RAg opportunities to address challenges in the agricultural sector.

Despite the achievements of initiatives such as eSoko, mainstreaming ICT4RAg initiatives has remained a challenge due to the lack of a coherent strategy, leading to failure to create synergies with other initiatives in the agriculture sector. Therefore, the ICT4RAg Strategy addresses these challenges to avoid ICT4RAg projects from being implemented in isolation, increase efficiency gains from better coordination, and create intra-sector and crosssector synergies.The strategies contained herein are based on good practice principles, offer clear leadership and direction, and should help to make agricultural and rural development more effective and responsive to the farmers' needs and expectations.

The ICT4RAg Strategy has also been developed through a meaningful multi-stakeholder process and their input is reflected throughout the document. It is therefore based upon a shared vision of all stakeholders on the increasing positive impact of ICTs in agricultural and rural development. It brings all stakeholders together to work towards common goals, which should increase the efficiency of the support offered to farmers by realizing potential synergies, avoiding duplication of interventions and increasing cost effectiveness of the services and support. Ultimately, it should guide investments in the use of ICT solutions for supporting agricultural and rural development, create strategic alliances on the use of ICTs among different sectors, eliminate silos between different sectors involved; and place key actors of the agricultural sector and smallholder farmers at the center of the strategy.

Executive Summary

Rwanda is primarily an agrarian economy that is in transition to a middle-income country by 2020. The transformation of agriculture into a productive, high value, market oriented sector, with forward linkages to other sectors is thus one of the pillars of the Vision. This transformation is also anchored in the belief that actively applying Information and Communication Technologies is critical to the transition of the economy to an information-rich and knowledge-based economy. This belief in the transformative power of ICT has led to the Ministry of Agriculture and Animal Resources (MINAGRI) in collaboration with other stakeholders, to develop a national ICT4RAg strategy that recognizes the achievements, challenges, and opportunities present in mainstreaming ICT in Agriculture.

The strategy further outlines the objectives, projects and programs required to implement the national ICT4RAg Strategy over the next five years (2016 – 2020). It is not a stand-alone strategy, but closely aligned with the national ICT strategy, SMART Rwanda Master Plan (SRMP) 2016 – 2020, and will continue to rely and coordinate its implementation with the SRMP execution agency, Rwanda Information Society Authority (RISA) for functional and implementation support and guidance.

Vision 2020, identifies six interwoven pillars, including good governance and efficient state, skilled human capital, vibrant private sector, world -class physical infrastructure and modern agriculture and livestock, all geared towards national, regional and global markets.

Guidelines

ICT4RAg focuses on the enhancement of agricultural and rural development through improved information and communication processes. More specifically, ICT4RAg involves the conceptualization, design, development, evaluation and application of innovative ways to use information and communication technologies (ICT) in the rural domain, with a primary focus on agriculture. The overall objectives are to make agricultural and rural development more effective and responsive to the farmers' needs and expectations. Thus, the national ICT4RAg Strategy has three principle guidelines:

1. a national ICT4RAg vision that corresponds to development and achievement of national agriculture modernization goals;
2. a national ICT4RAg action plan that reflects Rwanda's agricultural and rural development priorities; and
3. a national ICT4RAg implementation, monitoring and evaluation plan to manage the implementation and associated risks and measure the outcomes and impact of the stated objectives.

These guidelines have their reference in several national strategies related to the economic transformation through modernization of agriculture, namely, VISION 2020, EDPRS II, 7-Year Government Program (7YGP), the Strategic Plan for Agriculture Transformation, Phase 3 (SPAT III), and also closely aligned to the national ICT Strategy, SMART Rwanda Master Plan

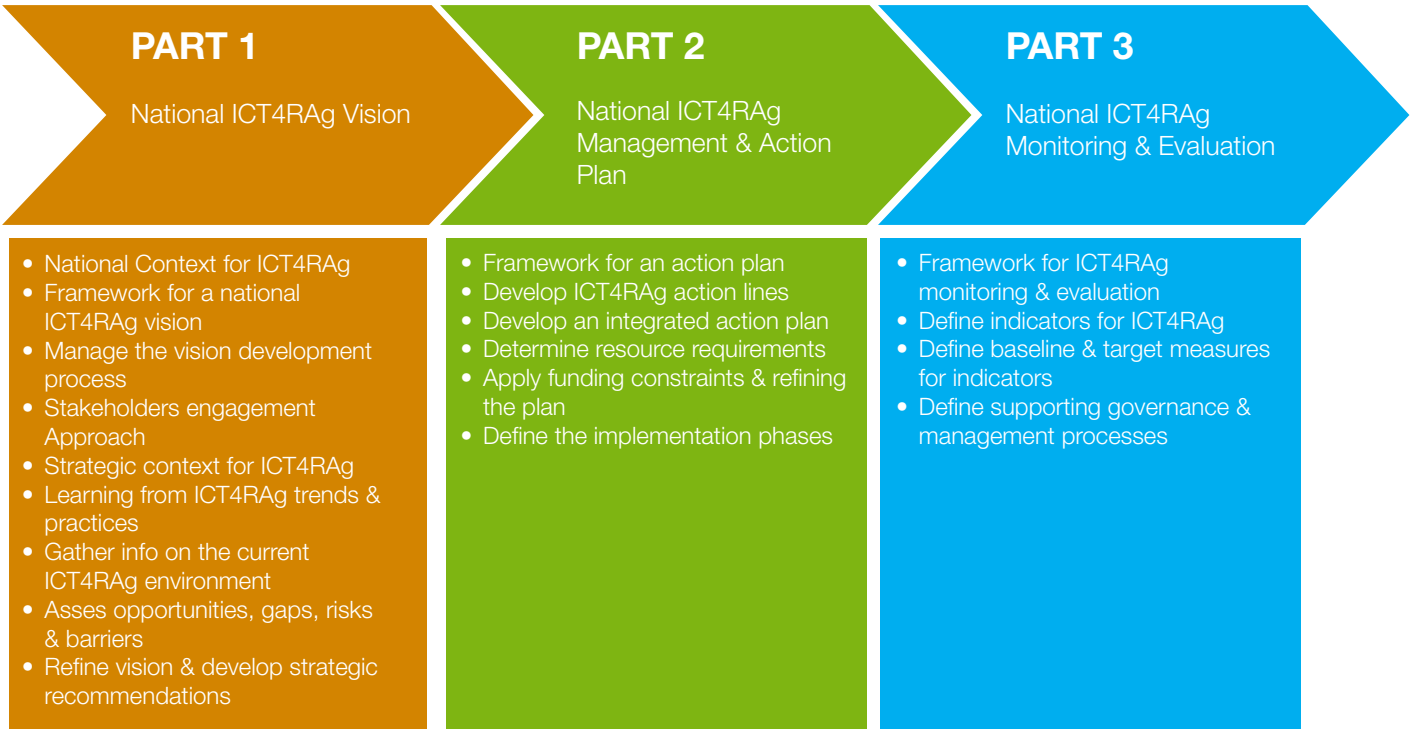


Fig 1. ICT4RAg STRATEGY FRAMEWORK

The ICT4RAg Strategy provides a roadmap to transform agricultural processes, systems, and infrastructure through identifying gaps, opportunities and solutions for the agriculture sector that will harness the transformative and cross-cutting powers of ICTs to accelerate productivity and efficiency in the sector. The strategy also shows how ICT services will support agricultural sector by providing appropriate, timely services and information to farmers and other related stakeholders. This strategic plan emphasizes the need for:

- increasing efficiency and coordination
- be based on good practices on the use of ICTs for agricultural and rural development
- guiding investments in the use of ICTs for agricultural and rural development
- create strategic alliances on the use of ICTs among different sectors developed through a meaningful multi-stakeholder process
- open up silos between different sectors involved
- put key actors of the agricultural sector and smallholder farmers at the center of the strategy
- farmers at the center of the strategy

Implementation

Implementation of the ICT4RAg Strategy should enable Rwanda to achieve rural development and poverty reduction to less than 30 per cent by 2020 through deployment of SMART Agriculture enabled solutions, as stipulated in SRMP. To ensure sustainability of implementation of this strategy, active use of innovative project financing models including but not limited to Public-Private Partnership (PPP), Challenge Funds, that shall be utilized to finance a majority of the programs and projects, appropriate green technologies, emerging or evolving innovations (both technological and business models) and compliance to common interoperability standards will be applied as stipulated in Annex 1. The Strategy also establishes key performance indictors specifically for measuring and evaluating the success of the program and projects.

{ Implementation of the ICT4RAg Strategy should contribute to poverty reduction to less than **30%** by **2020** }

Objectives

The overall objective of ICT4RAg is to achieve agricultural productivity increase through use of ICT by;

- Developing a common user interface and a repository database for farmer and farm information
- Increasing the number of skilled and knowledgeable farmers
- Spur job creation among youth in agricultural sector and peripheral services
- Improving and increasing access to agricultural information, knowledge and markets
- Expanding access to and the uptake of rural and agricultural financial services

Information and Communication Technologies are not the solution but the enablers for those who come up with the solutions. ICT4RAg strategies should promote empowerment, training and education as a transition to the requisite cultural shift, from top down prescriptive government directives to knowledge sharing, trust and transparency.

Monitoring and Evaluation

Monitoring and evaluation will be at the center of sound governance arrangements of the ICT4RAg Strategy. An effective and robust monitoring and evaluation (M&E) system shall provide support in measuring and understanding the impact of the national ICT4RAg strategy. The yardstick of successful and effective M&E system shall be the extent to which the M&E information shall be used to improve performance, inform budget decisions, manage programs, allocate accountability and affect policy making.

To effectively achieve the project benefits will involve integrating an independent M&E approach to understand the project risks and to undertake independent quality assurance on project deliverables at every milestone, advise on common pitfalls and set-up early warning mechanisms.

The M&E Action Plan shall contain key elements including influential champions such as;

1. creation of strong incentives both to conduct M&E and to use the information;
2. training in M&E and in using M&E information;
3. structural arrangements to ensure M&E objectivity and quality; and
4. a long-term commitment to institutionalizing M&E.

M&E is an extensive and highly collaborative process, especially with a complex set of inter-related focus areas and projects. The design and on-going implementation of such a process is very demanding and requires dedicated staff. It is therefore recommended that adequate resources with appropriate training in current M&E principles and practice be provided. The M&E Framework is detailed in Annex 2.

An effective governance structure with clear lines of decision-making and information sharing will be essential in solution formulation process and implementation, if significant accomplishments are to be made.

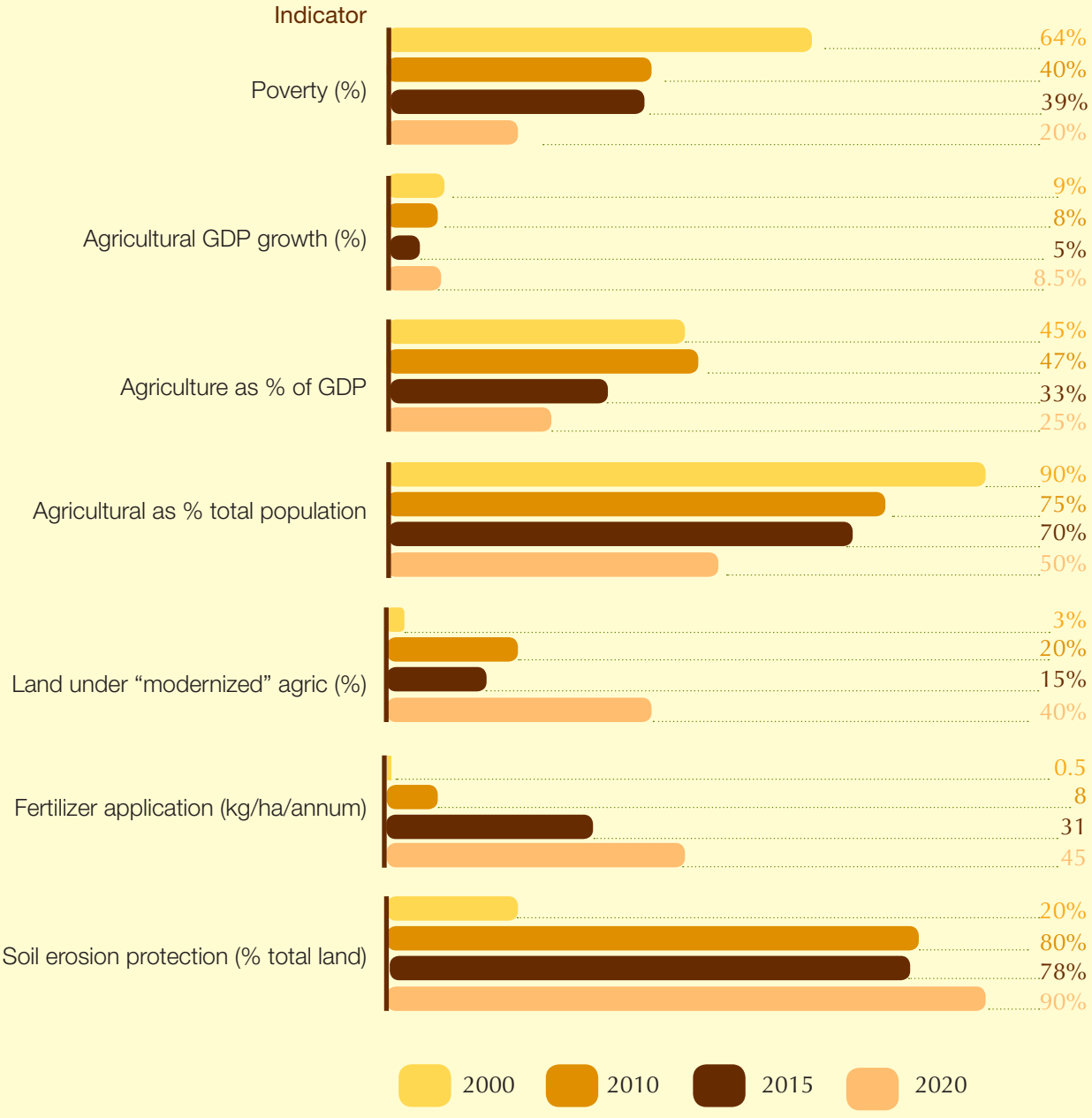
Resources

Building on past success of ICT programs in agriculture, the ICT4RAg Strategy will require even greater coordination and optimization of resources. The Strategy recommends a centralized ICT4RAg functional structure that will be under a Program Manager in the Single Project Implementation Unit (SPIU) at the Ministry of Agriculture and Animal Resources. This envisages reallocation of resources – both financial and human- from other MDAs whose roles and responsibilities are related to the e-agriculture objectives. The re-allocation should ensure that no significant increase in administrative or financial budgets required to implement the ICT4RAg Strategy. In addition, while significant financial resources are anticipated to implement the Strategy, it is envisaged that the innovative financing and resourcing models shall be utilized effectively to maintain the current budgetary allocations related to ICT4RAg Projects at the national government level. The 5-year Budget and Action plan is detailed in Annex 3.

Impact

The goals and objectives of a responsive, sustainable, effective and effective national ICT4RAg strategy are aligned to the national agricultural goals outlined in the Vision 2020 and EDPRS 2 as indicated in Table 1. below. These indicators have also been adopted as the principal key performance indicators of the ICT4RAg Strategy and shall be monitored annually and used as a yardstick to guide actions and interventions that may be required during execution of the Strategy.

TABLE 1:SELECTED NATIONAL AND AGRICULTURE-RELATED GOALS FOR VISION 2020



Source: MINECOFIN, MINAGRI

ICT4RAg has potential to contribute enormously in the efforts to achieve food security, and reduce food losses. At the same token, famers will be able to adopt modern technologies, sustain productivity with minimal damage to the environment, bridge the knowledge gap and create jobs opportunities. Through effective agricultural policy planning and coordination, ICT4RAg efforts will improve the efficiency of agriculture value chain by facilitating better access to market and benefit farmers by offering transparent, efficient and convenient financial services.

Management Structure

It is important to put in place a robust governance framework, bearing in mind the core objective of improving the effectiveness, co-ordination and efficiency of the ICT4RAg implementation. The governance structure proposed in the ICT4RAg shall ensure clarity of purpose, proper accountability, with clear roles and responsibilities. The establishment of the Single Project Implementation Units (SPIU) allows for the grouping of all the different project implementation units within the ministry under one single umbrella. This should help to better coordinate work, retain staff expertise and reduce duplication of work. The proposed structure is based on the following objectives:

- Improve the efficiency and effectiveness of ICT4RAg programs;
- Facilitate the monitoring and evaluation of the programs based on socio-economic impact factor assessment;
- Streamline information sharing and knowledge management by decreasing the transaction costs between government institutions and agencies through transparent reporting framework;
- Strengthen the coordination of public-private partnerships initiatives; and
- Promote the adoption and dissemination of best project management practices.

Policies, Laws and Regulations

No new policies, laws or regulations shall be required to implement the ICT4RAg. The current policies, laws, and regulations are thus sufficient to provide the necessary support. The key reference policies, laws and regulations are listed in the reference section at end of the document. However, as ICT evolves there could be new policies, regulations and laws required to support the strategic objectives. As when the requirement arises, MINAGRI shall take the lead to identify and develop the required interventions.

Ownership

Local ownership of the design and implementation of ICT programs, and participation of development professionals, the civil society and the private sector ensures a move away from a purely technology-centered strategy and from stand-alone-pieces of projects, towards those adapted to the needs and circumstances of resources and constraints. Using ICTs as a means for improving the economic conditions of the farmers, remains central to the ICT4RAg Strategy.

National ICT4RAg Strategy 2016 -2020

1. INTRODUCTION

1.1 Overview

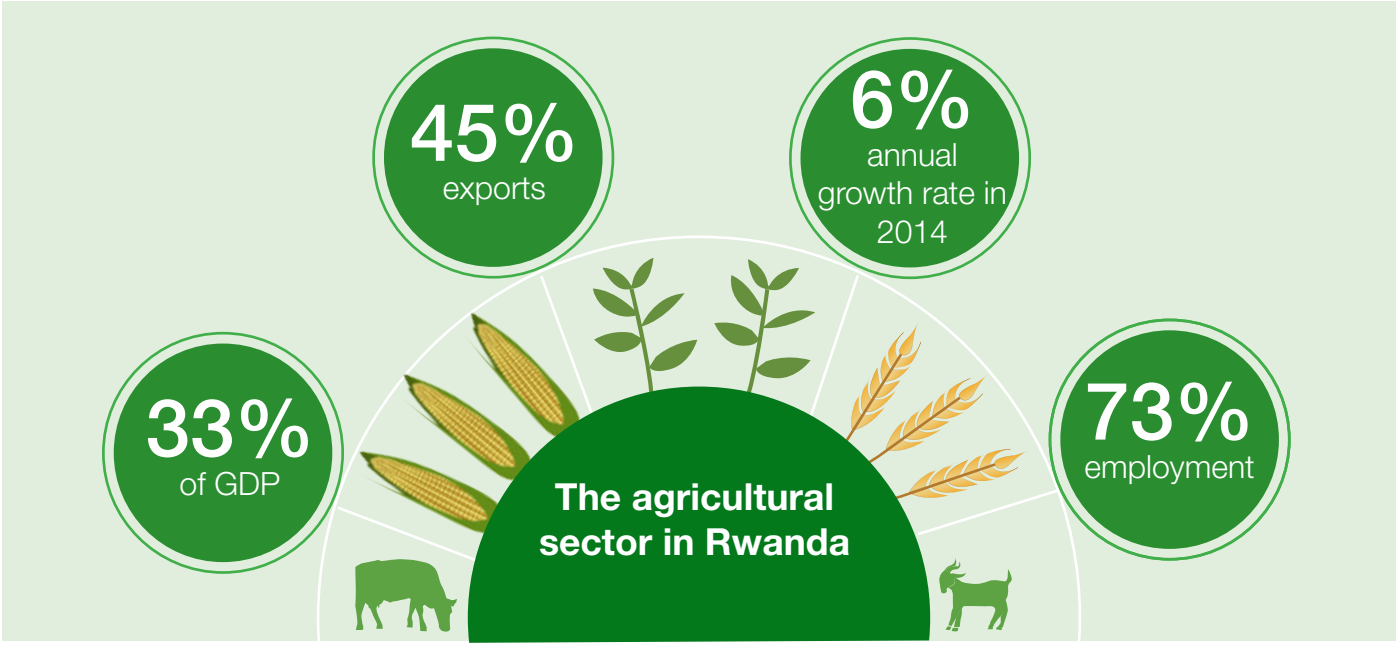
Increasing agricultural productivity is one the main drivers of poverty reduction in Rwanda. Agricultural transformation, especially through competitive value chain development, is expected to boost productivity in both the formal and informal sectors, with the effect of reducing the proportion of the population dependent on agriculture from the present 73 percent (2009) to less than 50 percent in 2020. There is therefore, considerable potential to increase commercialization of agriculture production, increase self-employment in small on and off-farm businesses, and achieve significant poverty reduction.

1.2 Background

The agricultural sector is the backbone of Rwanda's economy and contributes over 33 per cent of GDP with 45 per cent export earnings, while 73 per cent work in the agricultural sector, which makes the sector the biggest employer in Rwanda. The sector registered a 6 per cent annual growth in 2014, closely following the national growth rate of 7.8 per cent per annum. However challenges remain to transform agriculture from subsistence to a productive high value, market oriented farming. These challenges include: inadequate access to markets, low human capacity, small existing base of agro-processing, lack of access to agriculture finance and long term credit, inadequate access to advanced technologies, limited rural infrastructure, high production and transport costs.

ICT can play a role in addressing some of these challenges by offering access to information and solutions embedded in broader stakeholder systems. The strategic application of ICT to the agriculture sector then offers the best opportunity for economic growth and poverty alleviation when utilized as a holistic tool and used appropriately and effectively within the agricultural sector.

The ICT4RAg Strategy diagnoses the opportunities and the constraints in adopting ICT for agricultural development, and provides a clear implementation plan. The strategic plan recommends an expanded private sector role in ICT adoption, adaptation of available innovative ICT solutions, and results based monitoring and evaluation. The strategic plan further focuses on how ICT can be implemented and adopted for agricultural transformation, the different ICT innovations for agriculture available, existing policies, and infrastructure analysis all aimed at the development of a holistic and harmonized ICT4RAg strategic plan to improve agricultural sector service delivery.



1.3 Situational Analysis

The major constraints of implementing agriculture-based initiatives pertain to high costs to acquire power, appropriate equipment and solutions. The absence of a culture to use ICT also hinders the adoption of ICT enabled tools in agriculture. Further, there is limited availability of digitized extension material, expertise in project coordination, lack of a road map for systematic capacity building for agronomist and other agricultural extension workers, and limited communication and knowledge/information sharing culture. Despite these challenges high-level support of ICT for agriculture initiatives holds the promise of rapid change in the field.

Like all strategies and plans, the outcomes are not static and represent a specific understanding at a point in time of what the country needs to achieve in order to address its particular goals and challenges in the agriculture sector. Changes in Rwanda's strategic context will require a dynamic approach to updating the ICT4RAg vision and the associated action plan so that those continue to remain relevant. This requires understanding the key triggers for refreshing the vision and action plan, whether these are specific events that change the strategic context for ICT4RAg or a defined period of time after which are vision is required.

1.4 Governance and Management

The successful use of ICT in and for agriculture depends on implementation of broad range of initiatives and clear buy-in from the stakeholders. While the main drive for the ICT4RAg strategy derives from MINAGRI objectives, achieving the goals of increasing agricultural sector growth and moving towards a knowledge society requires a well-coordinated and collaborative multi-sector approach to reduce duplication in different ministries, institutions or service providers targeting the same stakeholders. The ICT4RAg Strategy therefore identifies and prioritizes projects and the alignment of partnerships with key priority areas, effective analysis of resource requirements, and the efficiency and scalability of innovations that respond to the real challenges in agricultural sector.

Ultimately, MINAGRI shall have the authority and responsibility for the overall coordination and implementation of the ICT4RAg Strategy under the SPIU. The coordination and governance of this strategy as illustrated in FIG. 2 below. The Agricultural Information and Communication Program unit shall be responsible for:

- Providing quality check for the ICT4RAg projects based on results and impact
- Providing guidance, advice, and support in the development and implementation of the ICT4RAg strategies and standards
- Advising on the acquisition, evaluation and acceptability process of ICT4RAg solutions, systems, hardware resources, and consultancy services.
- Promoting the harmonization of ICT4RAg development activities with existing or planned ICT solutions at other Government, civil society, and private sector institutions.
- Identifying and promoting strategic partnership programs and areas of collaboration between MINAGRI and other private institutions in deepening the implementation of ICT solutions in agriculture sector.

The unit shall be headed by a Program Manager who shall have the authority required to implement the strategy, and accept the responsibility for its outcome, with full authority over resources.

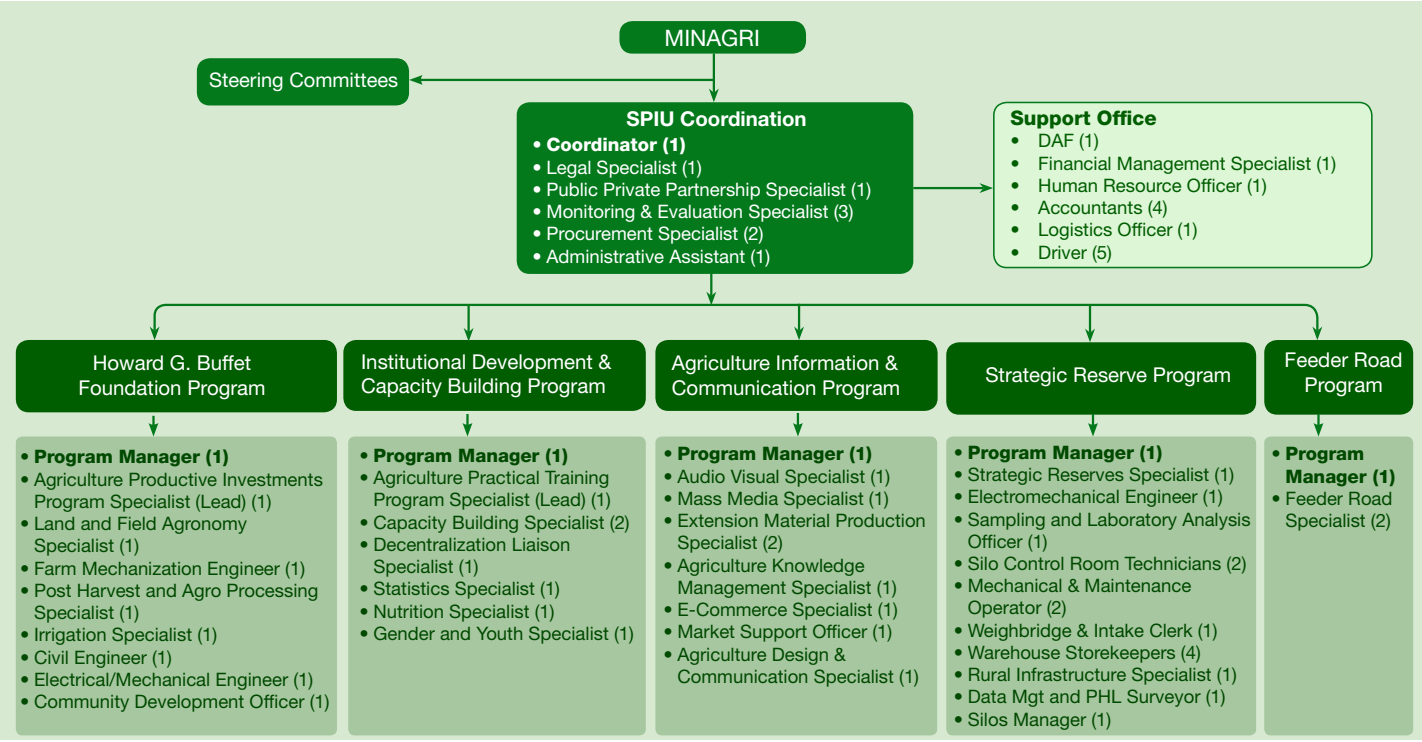


Fig 2. PROPOSED ICT4RAg MANAGEMENT STRUCTURE

2. VISION, MISSION & OBJECTIVES

The Strategic Plan for Agriculture Transformation (SPAT Phase 3, 2013- 2017) seeks to facilitate the development of Rwanda's agriculture, through an approach based on resource management, human capacity and private sector driven value chains. The intensification and commercialization of the Rwandan agricultural sector will be essential to reduce poverty and drive economic growth and transform the sector from subsistence to a market economy.

Rwandan agriculture in the last five years has been driven mainly by improvement in land management (soil erosion mitigation and terracing), irrigation, input provision, and increasing the national livestock herd. Developing and strengthening cooperatives has increased the sector's human capacity, accompanied by targeted extension, for example to improve the quality of coffee for export. There are also emerging initiatives to kick-start the market and facilitate commercialization, for example the rapid development of a decentralized rural finance network. However, the first four areas, land, water, fertilizer and cattle, have driven the major increases in sector productivity, improved rural incomes and reduced poverty.

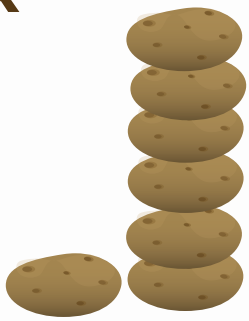
Achievements

Between 2000 and 2010

Maize yields increased almost **4x**

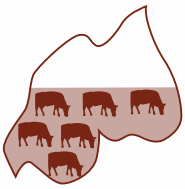
Wheat yields by **$2^{1/2}$X**

Hillside terraces farming have increased potato yields **6x**

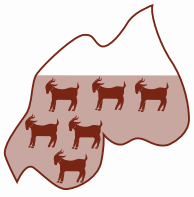


Through Girinka and small stock distribution,

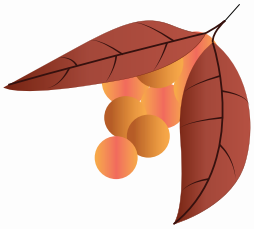
at least **47%** of farm households have at least one cow



and **53%** have at least one goat



Improving coffee quality and marketing have resulted in higher coffee prices



Legume production increased by **73%** from 2005 to 2010

2.1 Vision

eTransformation of agriculture in Rwanda through high effective and efficient use of ICT.

2.2 Mission Statement

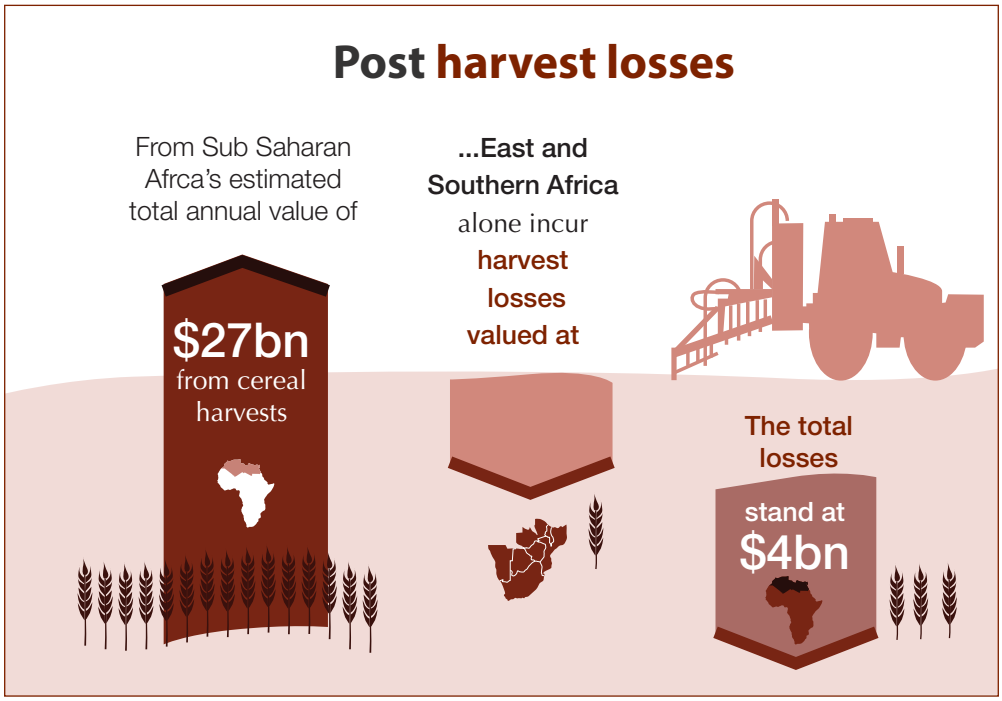
The ICT4Rag mission is to provide a conducive environment for the development, adoption and use of ICT in Agriculture, that is both affordable and accessible to all agricultural stakeholders and will accelerate the modernization of agriculture by addressing the identified challenges.

2.3 Guiding Principles

The sustainability of ICT in agriculture initiatives is an important issue, and requires addressing the financial, human and other resource constraints. The costs of ICTs need to be reduced, and the use of ICTs needs to be financially sustainable, a goal in which public-private partnerships (PPPs) will play an important role. Development actors need to better address the availability of appropriate and adapted content; the affordability of access, the development of farmers' capacity to use ICTs and available information, and the inclusion in ICT initiatives of women, youth and those lacking literacy and educational skills. Finally, reliable information is needed regarding the impact of previous initiatives, including lessons learned, in order to inform the design and approach of future efforts.

The guiding principles of the ICT4RAg strategy are to support the national development goals of the country through an integrated systems approach that will:

- Create a platform for increased PPP-led investment strategy and cost-effective allocation of public resources and private sector skills and capacity;
- Promote operational efficiencies and reduce transaction costs in the access to agri-finance and investment.
- Create local jobs at different parts of both ICT and agricultural value chains.
- Provide the room to mobilize funding of the proposed projects from GoR, its development partners, and other public or private institutions through Private Public Partnerships (PPPs) and other innovative collaboration models.



Source: APHLIS

2.4 Objectives

The broad challenges that have continually been faced by a large number of the farmer community have been: the lack of access to; finance, relevant information and markets which has led to poor farming methods and consequently poor productivity hence perpetuating the cycle of low investment in the sector and a deceleration of youth participation in the largest national economic sector.

The overall objective of ICT4RAg is to achieve agricultural productivity increase through use of ICT to:

- Develop a common user interface and a repository for farmer and farm information
- Increase the number of skilled and knowledgeable farmers
- Spur job creation among youth in agricultural sector and peripheral services
- Improve and increase access to agricultural information, knowledge and markets
- Expand access to and the uptake of rural and agricultural financial services
- The objectives are further explained in detailed in Section 4.

Challenges

Lack of "Common Platforms" for the farmers.

Insufficient use of ICT for agricultural purposes.

Lack of awareness regarding suitable agricultural methods among the farmers.

Agricultural content development and sustainability.

Inadequate use of Public-Private Partnerships to increase private sector investment in agriculture.

3. SITUATIONAL ANALYSIS

Ever since Rwandans have grown crops, raised livestock, and caught fish, they have required information from one another. Questions such as: "What is the most effective planning strategy on vertical slopes? "Where can I buy the improved seed and fertilizer this season? "How can I acquire a land? "Who is paying the highest price at the market?" What sells more or less at market place? "How can I participate in the government's credit program?" All these require appropriate and timely exchange of information. Farmers rarely find it easy to obtain answers to such questions, even if similar ones arise season after season. Farmers in a village may have planted the "same" crop for centuries, but over time, weather patterns and soil conditions change and epidemics of pests and diseases come and go. ICT4RAg solutions should provide consistent, appropriate, timely, and information to allow farmers cope with the changing environment and this requires carrying out a situational analysis. The analysis is based on the review of current and past ICT strategies.

3.1 Review of the National Information & Communication Infrastructure Plans (NICI I, II & III)

Key strategies for Rwanda's ICT sector were outlined in the National Information and Communication Infrastructure (NICI) plans. These four plans—each spanning five of the twenty years of Vision 2020—have guided the government's efforts in reforming and upgrading the sector. NICI I (2001 to 2005) primarily focused on building institutional and policy structures for future ICT growth and establishing an enabling environment to promote the development and growth of Rwanda's ICT sector. During this period, the government undertook a process of privatization and market liberalization, resulting in the establishment of two mobile network operators.

The second major policy for ICT in Rwanda, NICI II (2006 - 2010), had an ultimate goal of wealth creation, poverty reduction and employment generation. NICI II placed emphasis on programs in ten thematic areas, and with a budget of US$500 million, it also sought to enable an upgrade Rwanda's ICT infrastructure, including a national ID smartcard program, a national data center, and greater access to international bandwidth. In its evaluation of NICI II, the Government of Rwanda highlighted several shortcomings related to implementation governance, such as leadership, project management, and coordination issues, as well as the lack of systematic monitoring and evaluation. These shortcomings were addressed in subsequent NICI Plans.

NICI I 2001 to 2005	NICI II 2006 to 2010	NICI III 2011 to 2015	NICI-2020
Focused on building institutional and policy structures for future ICT growth	Ultimate goal of wealth creation, poverty reduction and employment generation	Focused more directly on ICT service delivery and targets local communities.	Consolidate the NICI process towards achieving the overall goal of the NICI series and Vision 2020
Establishing an enabling environment to promote the development and growth of Rwanda's ICT sector	Sought to enable an upgrade Rwanda's ICT infrastructure, including a national ID smartcard program, a national data center, and greater access to international bandwidth	Five themes that the plan: (1) skills development; (2) community development; (3) private sector development of the ICT sector; (4) cyber security and (5) e-government.	Re-named to the Smart Rwanda Master Plan(2016 -2020),
Government undertook a process of privatization and market liberalization			

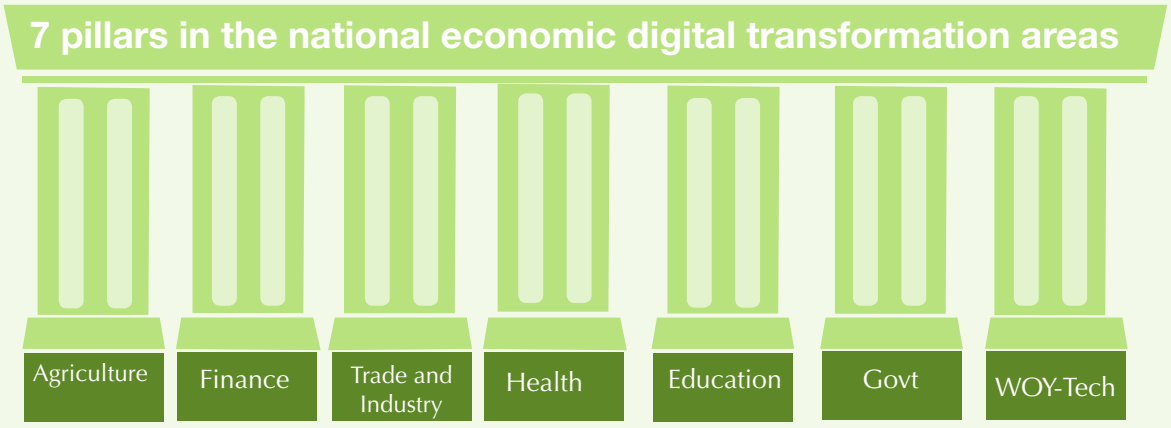
Since the first and second plans provided for the policy and infrastructure environment, the third NICI Plan (NICI III 2011 – 2015) focused more directly on ICT service delivery and targets local communities. The plan focused on five themes:

1. skills development;
2. community development;
3. private sector development of the ICT sector;
4. cyber security and
5. e-government.

However, these themes were no longer described as pillars or thematic areas, but as clusters. The change was due to lessons learned from implementation of NICI I and NICI II where on evaluation it was found that the plan was not flexible enough and work groups organized by pillars did not interact or cooperate effectively. The fourth plan, NICI-2020, sought to consolidate the NICI process towards achieving the overall goal of the NICI series and Vision 2020, that is, turning Rwanda into "an information-rich knowledge-based society and economy by modernizing its key sectors using information and communication technologies". The NICI 2020 objectives were successfully incorporated in 2013 into the ICT Sector Strategic Plan (ICTSSP) aligned to EDPRS 2and later re-evaluated and re-named to the Smart Rwanda Master Plan (2016 -2020), to better reflect ICT's transformative power into the overall national development document/strategy.

3.2 Review of the SMART Agriculture Strategy

SMART Rwanda Master Plan therefore constitutes the fourth generation of NICI Plans. It builds on all previous NICI generations as well as the ICT Sector Strategic Plan (ICT SSP 2013 ~ 2018) that was prepared to go in tandem with the EDPRS II. SRMP drew orientation from the Smart Africa Manifesto that was launched during the Transform Africa Summit in October 2013 where the African Union Heads of State signed the SMART Africa Manifesto in Kigali. The national economic digital transformation area is underpinned by flagship projects covering seven (7) pillars and three (3) enablers. The 7 SMART pillars are: Agriculture, Finance, Trade and Industry, Health, Education, Government, and Women & Youth Empowerment in Technology (WOY-Tech). The 3 SMART enablers are: ICT Capability and Capacity, Secure and Shared Infrastructure as well as Governance and Management. The SMART Agriculture objective is to transform agricultural practices to enhance productivity, and increased commercialization and industrialization through two focus areas, i. providing information for enhancing agricultural productivity and ii. establishing entire value-chain foundation for ICT-based agricultural commercialization and industrialization.



3

SMART enablers

- ICT Capability and Capacity
- Secure and Shared Infrastructure
- Governance and Management

3.3 Review of the Strategic Plan for Agricultural Transformation

The strategic vision for agriculture the next five years is a focus on both increased production of staple crops and livestock products, and greater involvement of the private sector to increase agricultural exports, processing and value addition. The vision is outlined in Strategic Plan for the Agriculture Transformation in Rwanda (SPATIII, 2013 -2017).

Although the sector has experienced significant progress over the last years under the implementation of SPAT I, SPAT II, and EDPRS I, the agricultural sector still faces various challenges. Agricultural growth over the last decade lagged behind industry and services, and there is limited private investment in the sector due to a perception of being high risk. Even though there has been significant development in land husbandry and irrigation, there has been a lack of consideration of environmental sustainability. Therefore, a further challenge is needed to address soil erosion and water conservation while also increasing productivity. Furthermore, diverse constraints affect agricultural value chains which limit production and potentialities of adding more values to crops and livestock products.

To overcome those challenges, more efforts are expected from all stakeholders through innovation, new products and a more knowledge based sector through ICT as enabler and an essential opportunity for the sector growth. The annual agricultural growth target of 8.5 per cent for the next five years is ambitious but achievable based on recent experiences. The major sources of growth will continue to be important, and new focus areas have also been added.

Under SPAT III, growth will be driven by:

- Continued investment in land husbandry, irrigation and inputs
- Expanding crop intensification program(CIP) to further increase the productivity of staple crops
- Expanding the livestock sector, particularly small stock and fisheries
- Investing in mechanization, processing and post-harvest facilities to modernize production
- Extension targeted at producers to develop a skill-based sector
- Research that responds to farmers' needs and identifies optimal crop varieties
- Aggregating smallholder production to provide sufficient quantities for markets
- Improving the quality of traditional export crops to generate higher premiums
- Increasing production of emerging export crops including horticulture
- Value chain development to strengthen supply and develop market demand
- Encouraging entrepreneurship through agricultural financing and insurance to reduce risk
- Attracting investment through soft and hard market infrastructure
- Building institutional capacity across the sector
- Facilitating a participatory approach, including women and youth, for inclusive growth
- Environmental sustainability and climate change adaptation for long term prosperity of the sector

The annual agricultural growth target of **8.5%** for the next **five years** is ambitious but **achievable**

3.4 Review of current context of ICTR4Ag

An ICT solution will be considered as an ICT4RAg activity if the solution contributes to agricultural value chains development and play a significant role in boosting agricultural sector and resulting rural development. This includes the use of computers, internet, geographical information systems, mobile phones, emerging technologies, Internet of Things (IoT) as well as traditional media such as radio or television (Steinem et al., 2007).

When thinking of ICT in agriculture, the phases in agricultural commodity value chain have to be considered and how appropriate ICT tools can enhance at each level of those phases. The figure below shows the example of main stages in agriculture and the information required in each stage. At each stage, knowledge and information must be delivered effectively and efficiently to the stakeholders. In order to achieve that, ICT enhanced services and tools may be employed appropriately to deliver quality information while reducing time and cost. In identifying the ways in which ICT can help agriculture, it is useful to view the farming life cycle as a three-stage process

Of course, some aspects of how ICT scan assist with agriculture are cross cutting, like the use of geographical information systems (GIS) for land-use planning, while others are broader than agriculture, such as their use in climate change adaptation. Nevertheless, this framework provides a useful basis for analysis through three stages:

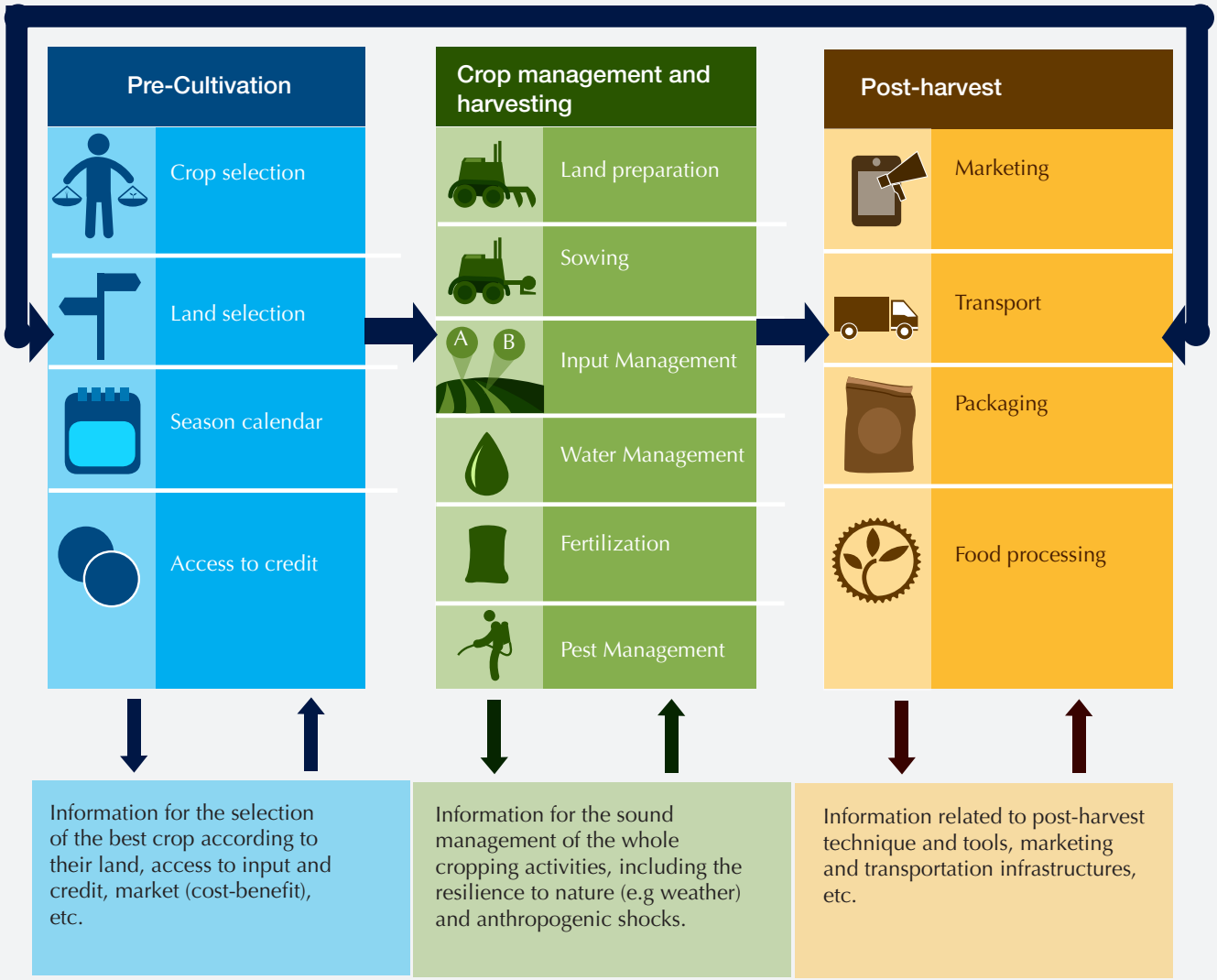


Fig. 3. Information required in Agriculture life cycle, Source MINAGRI

3.5 ICT in the Farming Cycle

From a farmer's perspective, the cropping cycle typically goes through three stages:

1. Pre-cultivation, including crop selection, land selection, calendar definition, access to credit, etc.
2. Crop management and harvesting, including land preparation and sowing, input management, water management and fertilization, pest management, etc.
3. Post-harvest, including marketing, transportation, packaging, food processing, etc.

Figure 4 below gives example of the information needed with or produced at each phase.

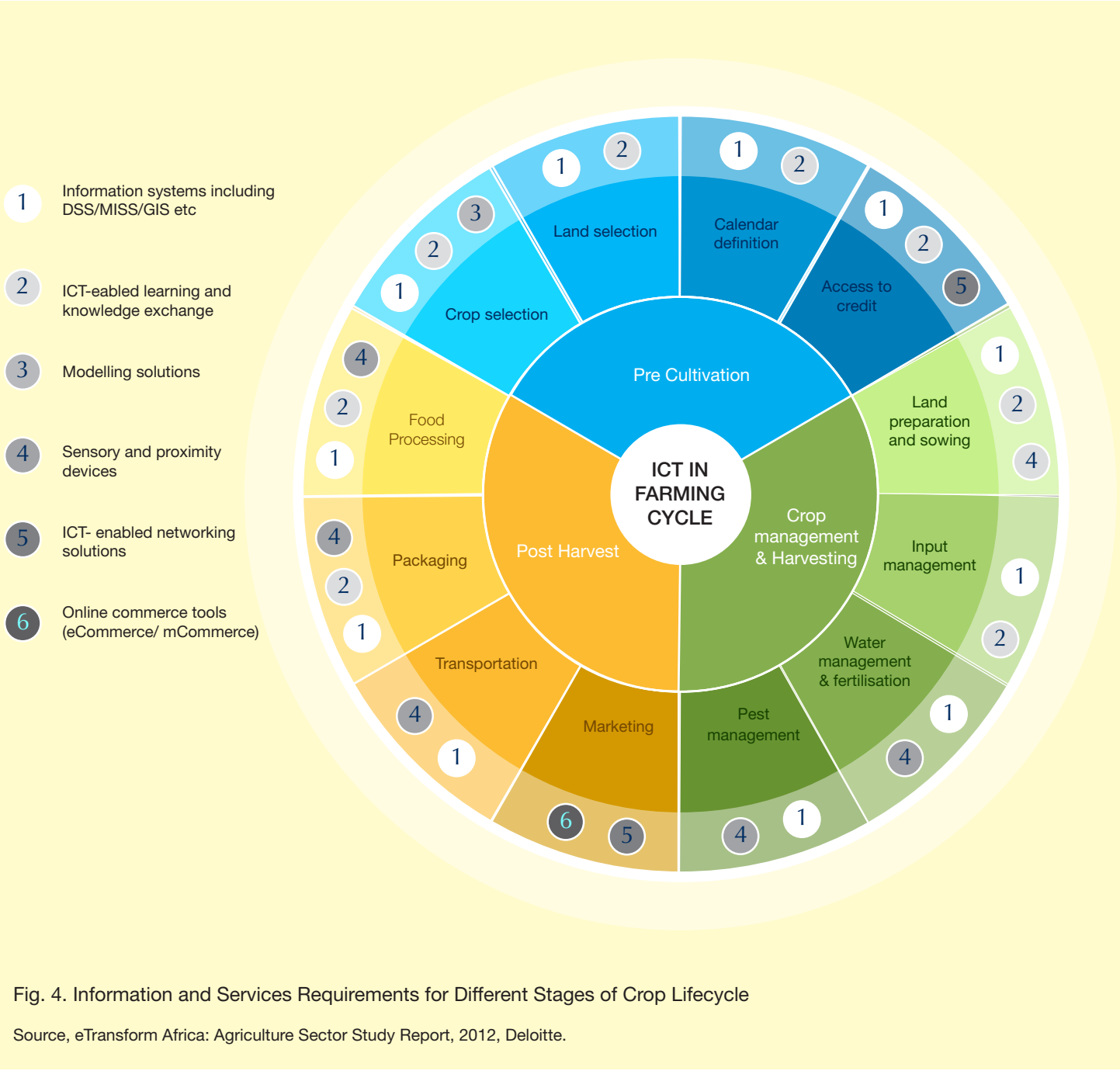


Fig. 4. Information and Services Requirements for Different Stages of Crop Lifecycle

Source, eTransform Africa: Agriculture Sector Study Report, 2012, Deloitte.

Whether giving advice or providing agricultural extension services, information to be delivered shall be different according to the problem or issue to be addressed at each level of the value chain. At each step of above value chain, an ICT solution / application is needed as enabler to systematically contribute and accelerate the growth of productivity. These appropriate solutions/applications may be specific at one level or on multiple levels, but all integrated/interconnected contributing to one end.

3.6 ICT4RAg Services, Applications and Infrastructure

During the implementation of SPAT Phase, I, Phase II and Phase III, ICT has been identified as a major enabler to meet the goals and objectives in the sector. In order to realize this promise, different IT applications/services have been developed by various stakeholders. The number of these services is growing every day and in order to further encourage this development and ensure sustainability and better co-ordination of emerging and evolving technologies, guidelines shall provide the conducive environment to develop solutions that respond to the real needs in agricultural sector and tap on agricultural employment opportunities. An integrated information system for agriculture stakeholders minimizes the duplication of data and ensures consistency, improves integrity of the data and can address a wide variety of information needs. Figure 5 below illustrates the ICT4RAg Solution Framework.

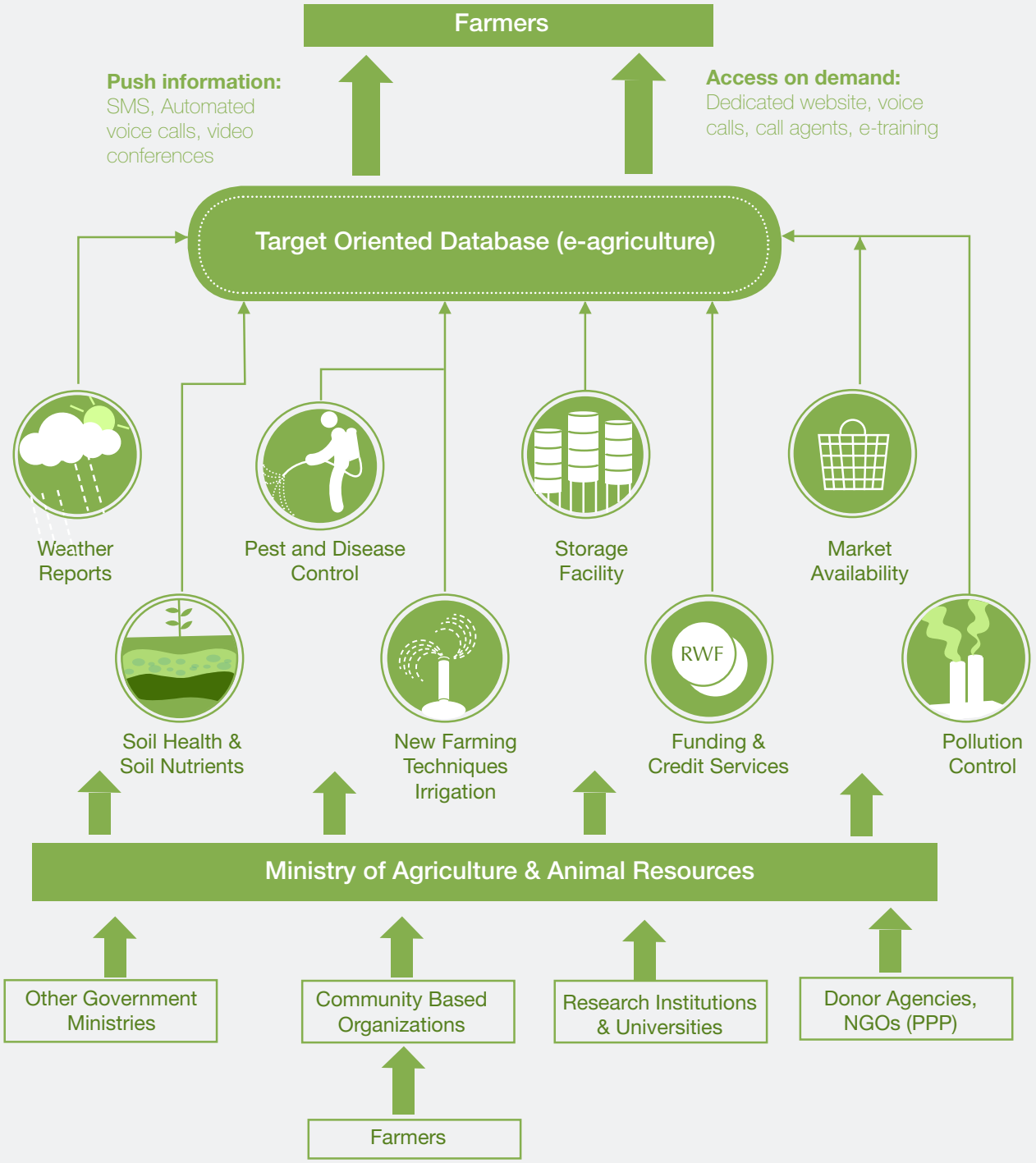


Fig. 5. ICT4RAg Solution Framework

ICT systems, shall preferably be modular in structure, so users with different requirements can select and use different components. In addition to mitigate compatibility risks, comprehensive and commonly accepted standards for communication, financing, information, and exchange must be applied across the agricultural supply chains. The Agriculture Technology guidelines in Annex 1. shall facilitate and enforce the development of standards to ensure that all agricultural actors and initiatives operate under a single preferred paradigm.

Current ICT4RAg Services and Applications:

Geographic Information System solutions(GIS): This provides agricultural map production which guides in planning and other related agricultural major decision. It also provides marshland plot mapping which facilitates in marshland and plots management.	**Mobile Payment/Banking/Credit Generation:** This facilitate access to credit acquisition, insurance,and other related services via mobile phone	**Agricultural management Information System (AMIS):** Agricultural Information gateway contains all agricultural information: reports, research, surveys, Audio and video extension material, Yellow and white page directories etc.
E-SOKO: This is a market price information system with collect relevant timely market price information which supports market actors and inform decision makers at different levels.	**Commodity Exchange:** Reduces market barriers to trading as well as generating transparent regional economy that can help financing to trader and farmers. It also provides auction facilities for agricultural and non -agricultural commodities.	**Micro weather stations:** This is for collecting information related to weather related information such as rain, temperature, humidity for agricultural insurance purpose and guide on other related decisions.
Online agricultural information repository/library: Agricultural library is accessible online with online cataloguing and location of the books in the shelves	**Hotline –** MINAGRI, NAEB and RAB have hotlines (4127/4675/3800) used to collect feedback and or inputs from the farmers and other agricultural actors.	**Pilot Automated Irrigation System:** This are automated irrigation systems available in different areasof the country especially in Eastern Province.
Weighbridge management system(NAEB - PHHS): A weighing and computing system with extensive data extraction, collection and processing functions.	**M-farm for agro-input distribution management:** This is an application supporting agro-input management.	**Silo warehouse management system:** This is an application that assist, manage, monitor and control the products stored in the silos. It also manages both humidity and heat control of the products stored in silos.
NozaUbuhinzi n' ubworozi website: This is an agricultural extension content management in a simple and intuitive website, developed by the minagri to share and disseminate agricultural technical / extension information to the extension workers and farmers with all information categorized by commodity. The content is available in pdf(hard copy of extension and promotion materials), audio (radio program broadcasted on weekly basis and sketches – ifumba y' ubukire) and training videos (ikivi, tv programs broadcasted on weekly basis).		

Other ICT4RAg tools

These are private-sector driven solutions either in pipeline or already at market. e.g. home-made egg incubator, picture based soil analyzing applications, and Agri-track (e-Haho) developed in ICT4RAg competitions and given an incubation period in CICA to promote and encourage solution development to address current agricultural trends and embryonic agricultural challenges.

ICT infrastructures in place as a result of the NICI Plans are:

- Mobile phones with a penetration of 74 per cent and 28 per cent Internet penetration.
- Combined mass media include 27+ Radio stations, 8 TV stations, and 32 publication houses with both printing and online capabilities.
- Local Government offices have video conferencing infrastructure, Tele-centers across the district, and Information Kiosks.
- Data connectivity infrastructure with Broadband connectivity, 4G LTE, Wireless LAN and Modems (Portable USB connectivity) are in place and slated to have 97% population coverage by 2017.
- Affordable ICT equipment as a result of Government efforts to promote ICT use in the society.

3.7 SWOT Analysis

SWOT Analysis used factual analysis covering a wide spectrum of the agricultural environment. The analysis took into consideration external as well as internal capabilities and environment.

Strengths, Weaknesses, Opportunities, and Threats (SWOT) Analysis

Strengths

- strong political support and will
- developed ICT infrastructure
- ICT4Ag initiatives
- high ICT awareness among youth
- strong institutional framework

Weaknesses

- Inadequate and weak co-ordination
- Poor information sharing
- Duplication of effort
- Poor content organisation and access

Opportunities

- Mobile penetration
- Youth involvement
- Inter-ministerial approach for ICT4Ag implementation
- Conducive environment for investment opportunity

Threats

- Lack of electricity
- Unique topography and micro-climate
- Lack of capacity and financial resources
- Lack of appropriate technologies
- Long time to market for Agriculture technology solutions
- Lack of national ICT4RAg stragegy guidelines

Fig. 6. SWOT analysis

Internet World Stats (Rwanda) 2015, http://www.internetworldstats.com/af/rw.htm

4 CORE OBJECTIVES, PROJECTS & SUBPROJECTS

4.1 OBJECTIVE 1. Development of a common user interface and a repository for farmer and farm information

I. Farmer Management Support System

This project will deploy farmers' management systems which include various different databases that will be used for services such as land/farmers registration, better crop cultivation (either crop rotation or not), whether those land are in crop intensification program (CIP), production prediction, decision support system for crop cultivation, seed distribution, fertilizer utilization, based on climate conditions, information and knowledge packaging, sharing and dissemination. Under this projects, 4 sub-projects are being proposed:

• **Farmer's Management and Information System: : T**he Farm Management and Information System (FMIS) s defined as the back- bone system for all other ICT solutions. FMIS shall provide a common user interface and a repository for farmer and farm information. It includes tools for communication and information exchange with external bodies, e.g. providers, values chains and government authorities. Decision support systems (DSSs) shall provide information for economically and environmentally appropriate farm management. Time-consuming and error-prone manual data collection may be replaced by automated information collection and storage. The FMIS will be a modular system to allow freedom of choice and use. The FMIS database will be deployed with such information as land registration, farmer's registration and link farmers to the credit, insurance, agro-input acquisition and other agro-services. This system intended to enhance farmer's financial capacity.

• **NozaUbuhinzi n' Ubworozi content management system: :** this is an intuitive and simple website packaging of knowledge and information to be used by the farmers for boosting production and productivity. This information/knowledge will be in video, audio, and other formats which will be intuitive for the farmers and the extension workers. The information repository (website) will be upgraded to be accessible through smart devices.

• **Variable-rate application (VRA))** is the site-specific application of fertilizers, pesticides or water. VRA requires empirical information on the current state of crop and soil, at a suitable spatial resolution, measured by sensors or human observation. Automated information exchange between different applications and components is essential to generate decisions for optimum applications. The incorporation of FMISs and DSSs in web-based approaches is a particularly important aim as technology costs decrease and the cost of agricultural input factors increases, the economic case for implementation of VRA will improve.

• **Early warning systems:** this system will prevent the agricultural losses and extraordinary situations through disaster warning mechanisms or time-sensitive alerts. Better water management and disease or pest prevention are also critical for increased productivity. Advances in technologies such as micro sensors, GPS, GIS, mediation software, mobile phones, UAV and satellite imagery have improved smallholders' ability to adjust farm strategies and reduce risk. At the same time, these advances allow Government and development partners to monitor agricultural productivity better, make more accurate projections, and allowing them to document improvements for future reference.

II. Agro-processing management system

Transforming primary agricultural products into other commodities to add values for market, better known as agro processing, could be enhanced greatly by using ICT. Since the agro-pocessing involves many stakeholders, strong coordination and collaboration is necessary.

III. Agro-smart traceability:

There is need to monitor agricultural products to ensure the quality of produce and productivity. This will be done based on variety of technologies/tools which may include RFID, tagging, or other mobile technologies. Based on information (system analysis and dissemination) that will be available through the system, farmers and other stakeholders could exercise make better control over pest and disease, and manage impending disasters. This project will have different systems/tools that will be developed to cater to variety of conditions available in Rwanda:

- Livestock management system: Using "ear tag"or other appropriate technologies such RFID among others for registration of cattle, the system will facilitate cattle (animal husbandry) management. The initiative will initially target those cattle that are under Girinka program and will be expanded to include all livestock. The cows will be monitored throughout their life cycle and farmers provided with value added services as disease prevention/control vaccination schedule, artificial insemination services, etc.

- Animal husbandry database: Databases which would manage variety of animal farming processes which include small ruminants, poultry farming, bee keeping, and fish farming will be established and managed to ensure increased livestock productivity and better planning.

IV. Agriculture Growth Management System

This project will involve growth management of agricultural products using sensor network technology. Different sub-projects have been identified to contribute to this project implementation:

- **Digital orthophoto for digital map:** Digital orthophoto quads (DOQs) can do much more than provide digital maps. By tracking the photos, it is possible to create water databases that are crucial to the success of irrigation. The databases can provide real-time information on heavily and sparsely irrigated locations, statistics on water use (and subsequently water users), drainage problems, and even salinity issues. By combining DOQs with other information (such as information on property ownership), the database enables water users to search for other water users, observe property boundaries, review monthly crop and water statistics, or obtain estimates of irrigation water demand in certain areas. Users have access to more accurate information when updating their infrastructure as well as more insight into potential maintenance problems (such as a system breakdown upstream). Assigning water rights and water fees are also easier with databases though in areas with greater demand, water prices can be expected to rise. Finally, a system like this can also prevents conflicts over water, because all users have access to the same factual information, such as price information and plot size. An important point, however, is that smallholders who typically use agricultural water to meet their own needs for sustenance may not be accustomed to the kinds of collective action needed to develop and sustain large water management networks. They may maintain an individual farm mentality even when technologies like DOQ databases are available.

- **Precision Farming through Satellite Technologies –** Precision farming through satellite technology utilizes three technologies: GPS (which can position a tractor within a few feet in the field), GIS (which can capture, manage, and analyze spatial data relating to crop productivity and field inputs), and variable rate technology (which provides site-specific, "on-the-fly" estimates of field inputs for site-specific application). When combined, the three technologies provide information that allows producers to apply inputs, such as fertilizer and insecticide, precisely where they are needed. The project could be combined with other tools such as micro sensors to enhance the data set and increase effectiveness of the precision farming.

- **Using Landsat to Assess Irrigation System –** Irrigation scheme: The project will focus on the use data from Landsat (which uses micro- sensors to record reflected and emitted energy from Earth) and other sensory data (including air temperature and humidity) to analyze cropping intensity, asses water productivity, and monitor equity in water distribution. The data are also used to compare the productivity of fields at the head (beginning) of the water source with the productivity of the fields at the tail (the most distant point from the water source). Landsat has the ability to "see" a variety of colors as well as near-infrared, mid-infrared, and thermal infrared light, which helps to distinguish differences between land plots or water sources. Initial results from Landsat images revealed critical similarities and differences between administrative zones that irrigation managers can use to determine and address the causes of yield variation (for example, low yields in fields near the tail). To gain even greater clarity on why irrigation may succeed or fail in a given location, remote sensing and GIS images can be coupled with other statistics like administrative boundaries, crop data, and poverty levels in GIS maps.

- **Agri-Simulation models:** The project will help to estimate crop yield as a function of weather conditions, soil conditions, and choice of crop management. Under this project, different simulation models will be developed using contextualized algorithms and applied to the real life agriculture situations.

- **Green house technologies:** greenhouse technology will be expanded in the 5 years span of the strategy. This will consider Greenhouse Heating systems, Greenhouse Control Systems, Greenhouse Irrigation Systems, Greenhouse Fertilizer Dosing Systems, Greenhouse Project Design, Integration and Installation, Greenhouse Drainage water recycling and quality check of Greenhouse Accessories and equipment.

- **Quality, safety and traceability of food and feed** are the main objectives of automated quality control. This is essential for ensuring safe, high-quality food produced under animal- and environmentally friendly conditions for a continuously growing market. Research is needed on harvest and post-harvest food- and feed-quality issues. Sample- based quality control is currently common practice, but future technologies should enable close monitoring of individual product quality. A crucial requirement is the permanent information exchange with FMISs for alerts, documentation, and automatic quality supervision and regulation purposes.

AN ICT-ENABLED JOURNEY INTO PROFITABLE FARMING

Community members, inspired by early adopters and their success, follow suit.

Due to their increased technical knowledge, increased recognition comes from parents, family and community members. These young farmers can be approached by extension workers, private sector companies and farmer organizations where they take new roles at different levels.

RWF

Early adopters of ICT for farm management see benefits and better returns, increased access to expert advice services and higher incomes, which in turn act as motivation to continue applying ICT tools on farming.

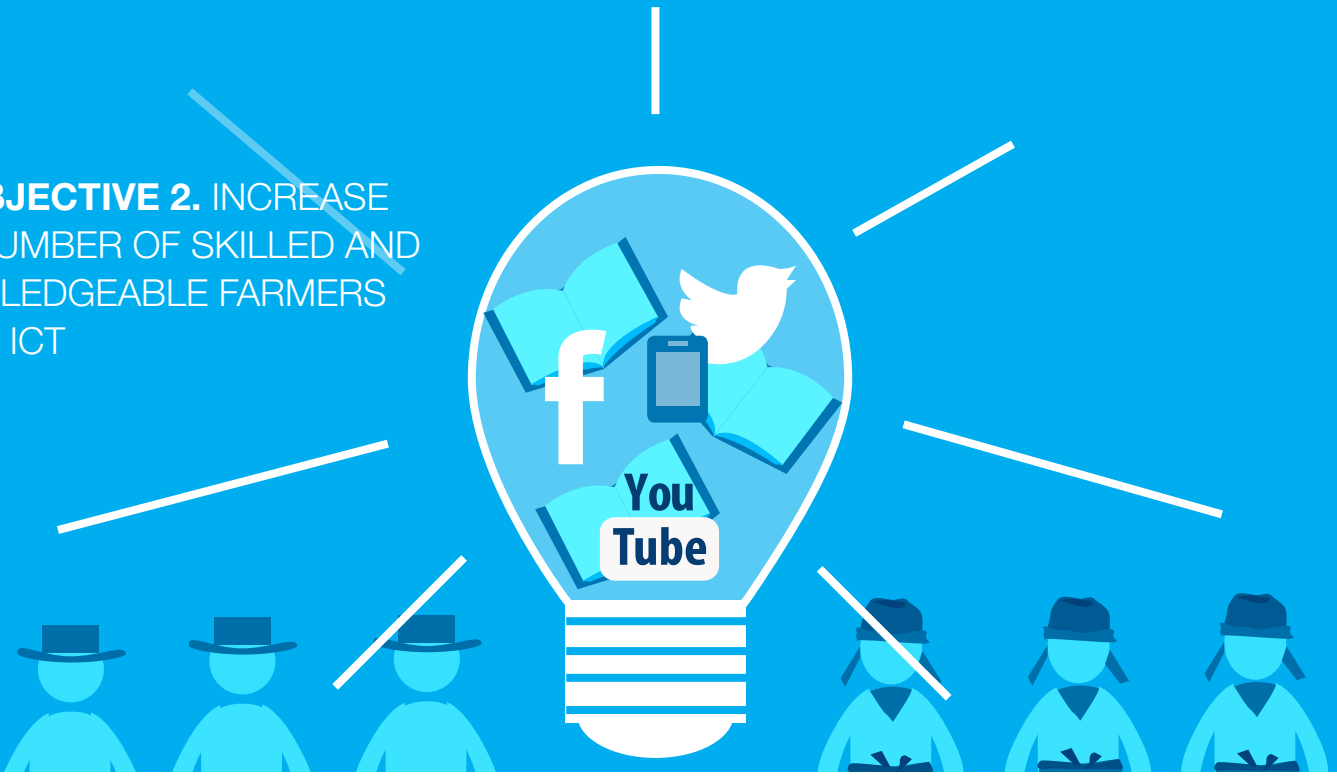
Young farmers start applying ICTs to obtain the best market prices, keep records, find crops in high demand, get information on pest and disease control, access new farming practices and agricultural technologies, and communicate with other farmers.

Young farmers are introduced to the digital world through general ICT skills, basic office productivity applications and Internet use trainings in the ICT centre. During training, youth can identify the potential of ICT to render their farming activities profitable

Challenges:
- low productivity,
- low income
- intensive labor render farming activities unprofitable.

Young farmers hear about the 'digital world': an appealing call that they do not want to miss out on. Some of the entry points: previous basic computer literacy – presence of an ICT Centre – need to access markets or increase production – to ease communication – as a doorway to a better job – as an alternative to long- distance travels for consultations.

4.2 OBJECTIVE 2. INCREASE THE NUMBER OF SKILLED AND KNOWLEDGEABLE FARMERS USING ICT



In partnership with national and international development agencies, series of training events (based on a cost-sharing model) shall be held to raise awareness and stimulate the adoption of ICT and social media learning opportunities in order to strengthen actors operating in the agricultural sectors. This social innovation process is at the basis of an integrated capacity development approach aimed at strengthening farmer organizations' ability to use technology to increase, sustain and benefit from agricultural growth. In this context, ICT solutions shall be identified and mainstreamed in field activities in ways that promote inclusion of smallholder farmers in agricultural value chains. The key success factor is that diverse capacity-development activities are required for effective and sustainable ICT use over time, especially at the organizational level. The rapid development of technologies places high demands on the education and training of farmers. National and transnational agriculture knowledge and innovation systems shall place a greater focus on the continuous training and qualification of farmers and farm consultants.

Capacity development is understood to be broader than training interventions. It also includes coaching and mentoring, analyzing information and communication flows and providing support to local partners to formulate the objectives for implementing ICT solutions, sharing knowledge, building relationships and networking with local technical providers and resource persons. Capacity to design, develop, implement and maintain ICT solutions requires guidance and support through the business transformation processes that take place when ICT tools are adopted for agricultural purposes. For example, farmers will be trained in using ICTs to receive and use market price information and short messages with production information on their mobile phones. This will further link farmer organizations and local service providers, ICT advisors and research institutes to provide accurate and timely information. The youth shall also be trained to use ICTs to improve production and farm management and influence the motivation of young farmers to embrace farming as a profitable business. The objective being showing youth their capability of increasing their income but also gained respected social status in their communities.
Low levels of literacy among farmers is a major challenge in the sector. Farmers lack business skills like record-keeping, understanding market needs, and the standards required of their produce. This also makes them less appealing for financial institutions to take on as clients, and therefore there is a need to transform the sector from subsistence agriculture to a more market-oriented approach, to improve the credibility of farmers when borrowing from financial institutions.

The projects under this objective are:

i. Farmer Query System. An integrated ICT approach which includes mobile and web apps, multimedia content for mobile phones, and even community radio programs. When farmers in the community face a particular agriculture challenge, through this app they send the details of this problem to a call center where expert agriculturists respond to the query through a phone call, becoming a virtual extension agent.

ii. Agriculture Knowledge Portal, an online repository of agricultural content which can also be accessed through mobile app, will be developed to solve the challenge of updating the extension agent with most recent knowledge. The knowledge portal, which is also linked with learning tools and powers the various diagnostic tool, aids extension agents to learn more about each of the topics with updated information. To automate the reporting and data collection process of extension department a mobile application which automate their scheduling process, statistics collection and problem tracking, with the positive result of eliminating a lot of paperwork.

iii. E-agricultural training works to increase agricultural productivity by training small and marginal farmers via short instructional videos. The approach is to collaborate with local partners to train rural communities to produce videos by farmers, of farmers, and for farmers, and promote the exchange of information on agricultural practices

4.3 OBJECTIVE 3. SPUR JOB CREATION AMONG YOUTH IN AGRICULTURAL SECTOR

The younger generation will be interested in taking to farming as a profession only if farming becomes both economically and intellectually attractive. The future of food security in Rwanda will depend on both the strengthening of the ecological foundations essential for sustainable agriculture, as well as attracting the educated youth to farming and allied professions such as animal husbandry, agro-processing and agri-business. Empowerment of youth by using ICT should help young farm women and men to earn income from both farm and non-farm enterprises.

I. Support for ICT4RAg innovations:

Different initiatives like competitions, capacity building schemes, introduction of new technologies and incubation support among others will be conducted to support maturing and implementation of ICT4RAg innovations. It is essential to introduce appropriate technologies and business models for incorporating third-party software and hardware in farm-management systems and for sharing of essential data. The following are some sub-projects planned under this objective:

• Foster local and appropriate agriculture innovation systems and tools: To empower capacity of different young entrepreneurs in area of ICT4RAg, there will be some projects related to the new technology capacity building. Some of the new technology planned to be used in this context are, Internet of Things (IOT) projects, introduction of drones (UAV) in agricultural sector and strengthening the capacity of KLab / FabLab members, academic and research institutions and other innovation centers (e.g.PDU)to develop some of these technologies/tools.

• Create home grown agricultural solutions/tools through FabLab (e.g. micro sensors etc.): Through frameworks between MINAGRI, Klab/Fablab and other innovation centers (e.g. PDU), different micro sensors will be developed and used to support agricultural service delivery.

II. Online Diploma in Agro-technology

To bridge the existing knowledge and information gap for farmers, build an e-learning program for the farming community in both Kinyarwanda and English, which is an ICT-based agricultural education system to improve productivity, income and socio- economic status by disseminating a fresh expert agricultural advice to farmers. Agricultural experts generate lessons based on relevant information and knowledge on all agricultural practices received in the form of text and digitally converted lessons developed on online Learning Management System

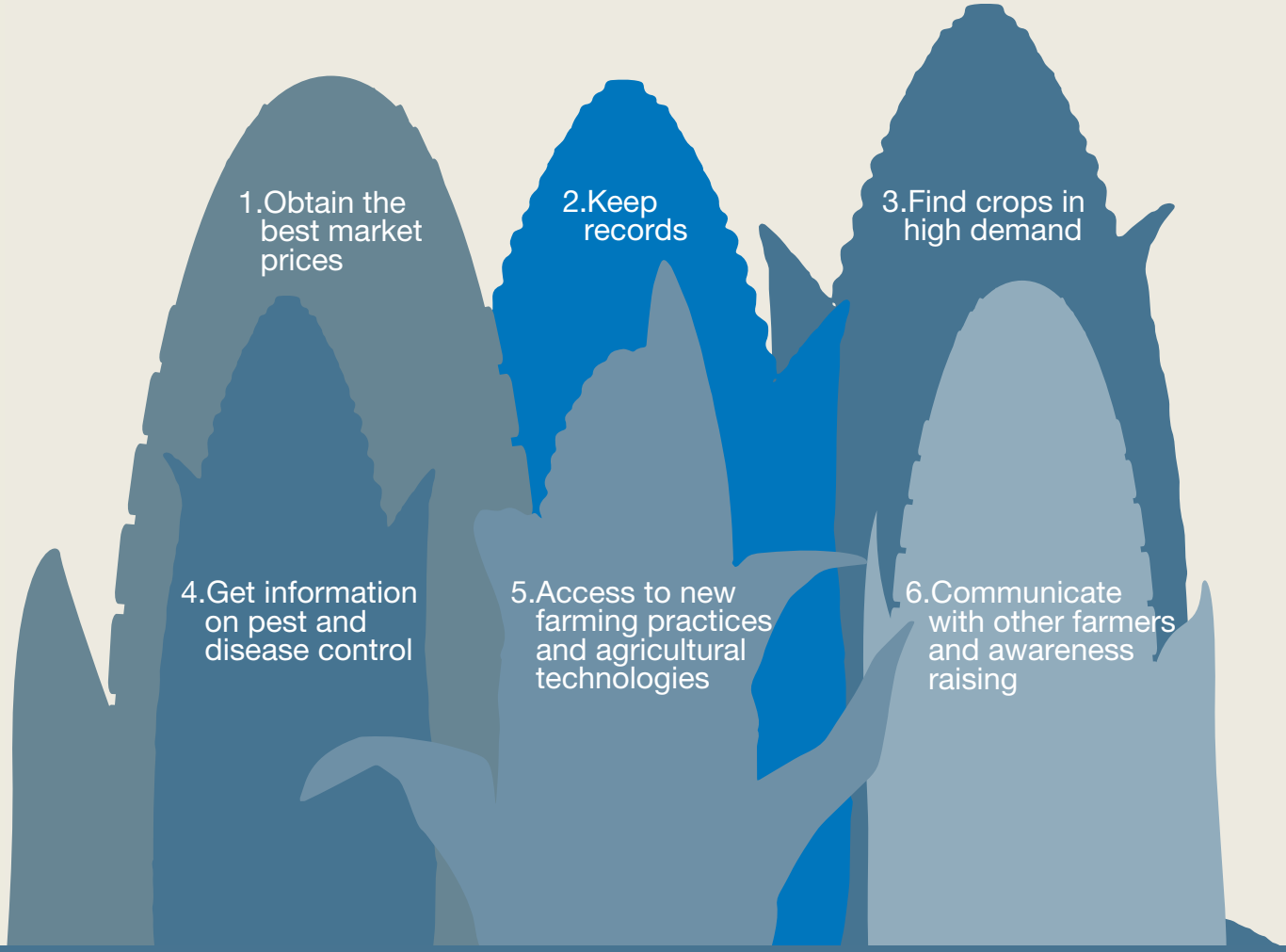
II. 'Farming is Cool Rwanda ' initiative

This initiative is aimed at changing youth mindset towards agribusiness, while empowering youth with technology, knowledge, skills, support and financing to engage in modern agribusiness. Agriculture has an image problem for the majority of the youth, who view agriculture unattractive and only as back-breaking labor, without an economic pay-off — and little room for career advancement. However, the agricultural sector offers huge potential for job creation and realizing this can radically change the image of agriculture among young people. Increased access to education and new forms of agriculture-based enterprise mean that young people can be a vital force for innovation in family farming, increasing incomes and well-being for both farmers and local communities. Young people can transform the agricultural sector by applying new technologies and new thinking and increased use of ICT can be one of those ways in which youth can play a role as innovators. Agriculture means more than subsistence farming - today, young people can explore career options in perma culture design, biodynamic farming, communication technologies, forecasting, marketing, logistics, quality assurance, urban agriculture projects, food preparation, environmental sciences, advanced technologies, and more.

The Ministry of Agriculture and Animal Resources working with farmers, businesses, policy-makers, and educators will continue to promote agriculture as an intellectually stimulating and economically sustainable career—and make jobs in the agriculture and food system "cool" for young people in Rwanda.

"Feeding a global population of just over **9 billion** in 2050 will require a **70 per cent** increase in global food production. This will require that agriculture particularly smallholder agriculture plays a much more effective role' IFAD

NEW WAYS OF 'HARVESTING' INFORMATION



4.4 OBJECTIVE 4. INCREASE ACCESS TO AGRICULTURAL INFORMATION, KNOWLEDGE AND MARKET

I. Making agricultural information dissemination/ services affordable in rural areas through CCI, BDF, SAPs/ Telecentres

The Government of Rwanda has put in place different ICT infrastructure including ICT centers at district level and sector level. Some of these centers have privatized (30) but more than 62 still remain under management of the district. The centers have computers with internet access, scanners, printers and photocopiers. The strong partnership between these centers and CICA (Agricultural Information and Communication center) will be strengthened so that all the services to be provided to the farmers will be accessible in those centers at an affordable cost. Increased use of information and its effective communication shall contribute greatly to the decisions that farmers make. Improving or altering information "density," its structure and distribution greatly contribute to the expansion of the stock of knowledge the sector depends on with ICTs facilitating the spread and "distribution" of knowledge throughout the sector as well as a rapid generation of new knowledge.

II. Esoko+:

ESoko+ is the second version of eSoko, a Market Price Information System. It will improve small-scale agricultural production and increase linkage to remunerative markets through ICT, thus leading to improved food security. This platform will have a goal of providing sufficient agricultural market information to participants in the agricultural markets to improve agricultural marketing services (government, producers, cooperatives, traders, transporters, processors, retailers, entertainment industry, and consumers).

III. Agriculture Information Service Center

The center will be a repository of all agricultural information which will be available to whoever needs the information to enhance agriculture related activities. The following are the sub-projects identified as priority projects:

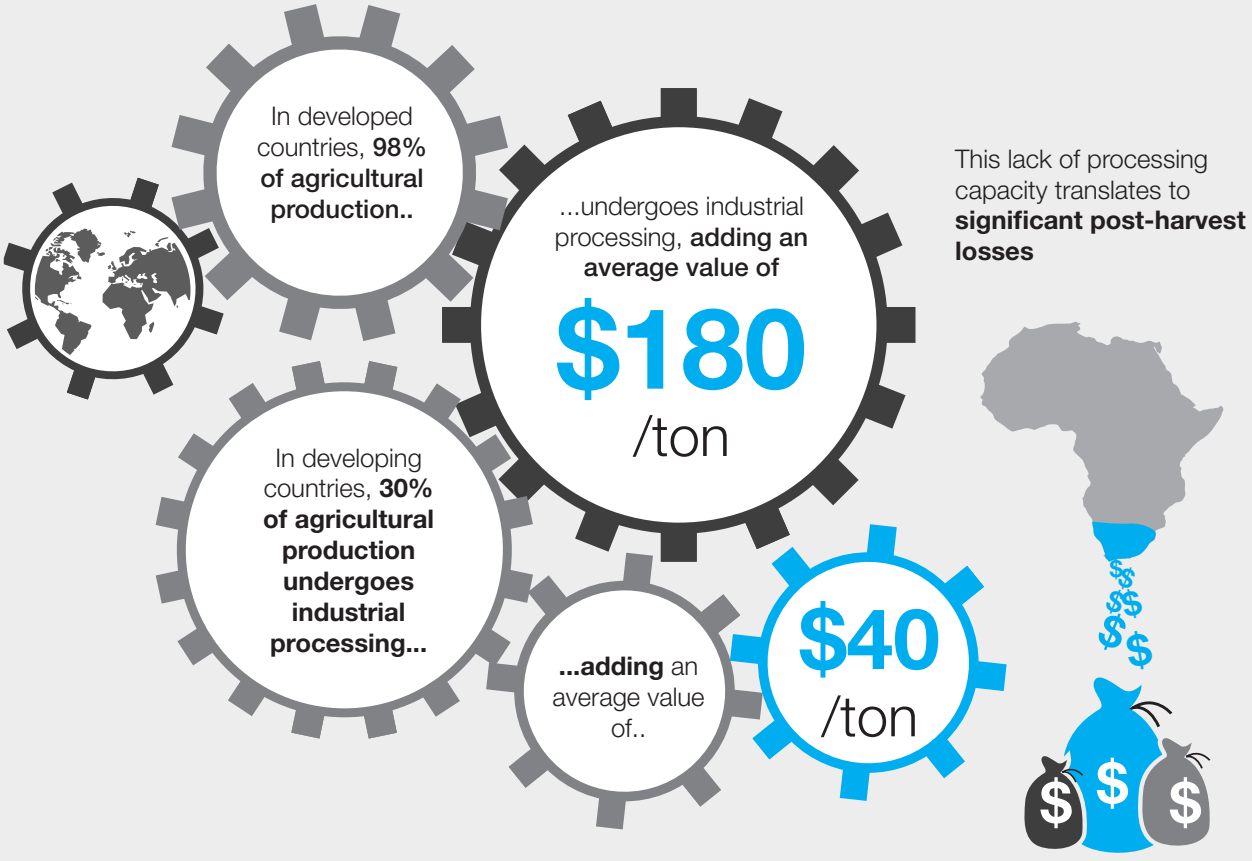
- Using radio, video, and other appropriate medium to reach Rural Farmers: Among the various communications media available, even the most novel and technically sophisticated alternatives, radio remains the most pervasive, inexpensive, popular, and socio-cultural appropriate means of communication in many parts of the developing world. Radio is still the only medium for disseminating information rapidly to large and remote audiences, including critical information about markets, weather, crops, livestock production, and natural resource protection. Video has also made substantial impact in convincing farmers to try new technologies; its images and demonstrations make information easier to understand and apply. So, this will strengthen agricultural communication, knowledge management and agricultural extension service provision.
- Strengthening Call Center: By introducingCRM (customer relationship management)software, the call center will be strengthened to improve agricultural extension and early warning services delivery ,improve effective communication for agriculturalsector (Top- Bottom and Bottom –Up Communication / duplex) and provide the linkage and complementarities between MINAGRI and its stakeholders.
- Use of Big data technologies: Big data is a term that describes the large volume of data both structured and unstructured. While the term "big data" is relatively new, the act of gathering and storing large amounts of

information for eventual analysis is ages old. So, before identifying the big data technology to be used in that act of gathering and storing a large amount of data, there will be analysis on the source of data (streaming data, social media, public source, and soon), which data can be kept and which one cannot, which data can be analyzed and how etc. then after that, cheap, abundant storage using cloud computing and other flexible resource allocation arrangements.

IV. Crop management practices

Crop management Practices must be tailored to location-specific needs in order to produce sufficient food at affordable prices for consumers and with higher profitability for small-scale farmers, If the application of nutrients as fertilizers is inadequate, it may result in a loss in yield and profit. On the other hand, applications beyond the crop's need not only reduce profit but also increase risks to our environment. For many farmers, fertilizers are the second-largest expense after labor. A mobile app to provide farmers with advice on the optimal timing, amount, and type of fertilizer to apply to their crop to maximize production and profit and reduce waste. The app collects information from a farmer through easy-to-answer questions about the farmer's cultivation conditions. The answers are transmitted to a 'calculator' which uses a database to develop a fertilizer recommendation matching the specific needs and rice-growing conditions of that farmer. Farmers by dialing a number to hear a voice recording in the local language. The farmer then follows the voice prompt to answer simple questions about their growing conditions by pushing appropriate numbers on the phone keypad. After all questions are answered, the farmer receives a tailored fertilizer recommendation as an SMS.

The value of **processing**



Source African Development Bank

4.5 OBJECTIVE 5. SUPPORT ACCESS TO AND THE UPTAKE OF AGRICULTURAL FINANCE

ICT4RAg seeks to address smallholder farmers lack access to critical information, market facilitation, and financial intermediation services. Financing small-scale farmers is challenging given the cost and risk associated with serving rural, and relatively isolated clients, however, lending becomes increasingly feasible, in a supply-chain approach in which farmers are connected to a formal network of buyers, retailers, and financiers. Other characteristics related to the agricultural sector, such as unpredictable weather patterns, long crop cycles, irregular market access, and volatile or high farm input costs, make financing even more unappealing to financial institutions. A supply-chain approach to promote agricultural lending through targeted use of information and communication technologies (ICTs) across the platform shall make the process efficient, cost-effective, and practical.

I. Data as a source of risk-based lending

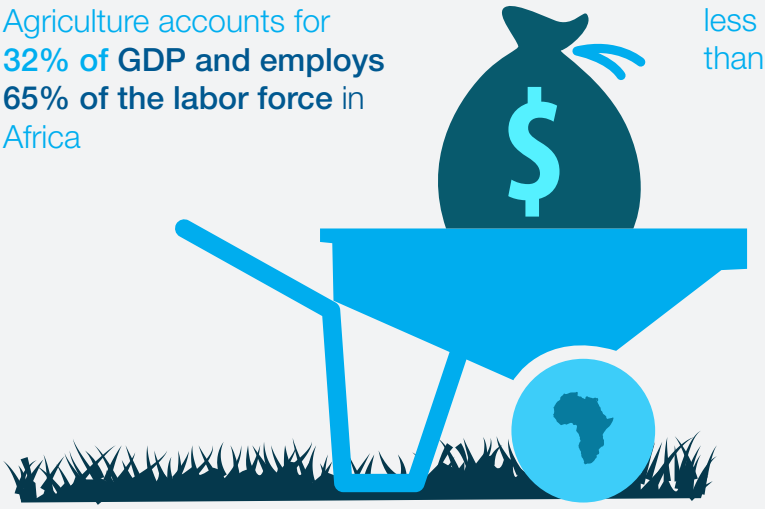
Agriculture accounts for thirty-two per cent of GDP but less one percent of bank loans in East Africa currently go to agriculture, mainly because a lack of data on small holder farmers means that lenders can't assess the risk. The solution is to create a network of farmers and collect their data, using it to create credit models which allow banks to vet farmers for loans. This real-life network would need to collecting data from population distribution, predominant crop types and soil types, to previous weather patterns and estimates of supply. Smallholders need access to capital, seeds and fertilizers, crop insurance, storage, and distribution but their risk profiles make the cost of capital too high, simply because there isn't good data. The development of a common platform would address this lack of data. By quantifying the risk of a loan may help credit model which predicts the ability of a borrower to repay and determine the interest rate accordingly. The data will need to be kept current by allowing the farmers update the data themselves, and involving enterprises delivering agricultural services to the farmers.

II. Development of appropriate agro-finance products

Increasing finance and investment to rural areas is a vital part of addressing food security and poverty reduction. However, a number of factors continue to hinder the development of vibrant financial markets in the rural areas of Rwanda. The higher transaction costs associated with inadequate infrastructure, along with particular needs and high risk factors inherent in agriculture result in an under-provision of financial services in rural areas. Furthermore, where services are available, products are often designed without consideration for the needs and capacities of rural households and agricultural producers. Lack of access to finance is a key impediment to farmers in improving the efficiency of their production and adopting modern technologies.

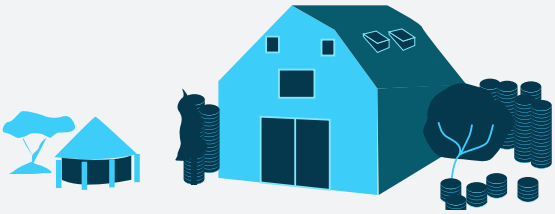
Agricultural commercial lending

Agriculture accounts for **32% of GDP and employs 65% of the labor force** in Africa



less than **1%** of commercial lending goes to agriculture

Morever, most of the loans to the sector go to large scale farmers, **leaving smallholder farmers underserved**



Source: African Development Band and World Bank

Increasing finance and investment to rural areas is a vital part of addressing food security and poverty reduction.

4.6 FLAGSHIP PROJECTS

The aim of the Flagship Projects program is to support long-term projects of strategic character that significantly contribute to transforming the face of agriculture in Rwanda. Flagship Projects are meant to support the transformation process, strengthen institutional capacities, and contribute to the ongoing development of the sector. The total budget of the flagship projects is estimated at Rwf 13.5 billion out of a total estimated budget of Rwf 34 Billion for all projects planned for implementation under ICT4Rag Strategy, over the next 5 years. It is envisaged that the flagship projects will be financed by the Government of Rwanda under the support and management of MINAGRI. The other projects with an estimated budget of Rwf 20.5 Billion (refer to Annex 3), will be mainly private sector led. To ensure sustainability of implementation of this strategy, active use of innovative project financing models including; Public-Private Partnership (PPP), Challenge Funds, Endowment Funds, Venture Capital, Seed Capital etc. shall be utilized to attract private sector investment.

1. Farmer's Management and Information System: The Farm Management and Information System (FMIS) s defined as the back- bone system for all other ICT solutions. FMIS shall provide a common user interface and a repository for farmer and farm information. It includes tools for communication and information exchange with external bodies, e.g. providers, values chains and government authorities. Decision support systems (DSSs) shall provide information for economically and environmentally appropriate farm management. Time-consuming and error-prone manual data collection may be replaced by automated information collection and storage. The FMIS will be a modular system to allow freedom of choice and use. The FMIS database will be deployed with such information as land registration, farmer's registration and link farmers to the credit, insurance, agro-input acquisition and other agro-services.

Budget: Rwf 6.0 Billion

2. e-soko+. This is the second version of eSoko, a Market Price Information System. It will improve small-scale agricultural production and increase linkage to remunerative markets through ICT, thus leading to improved food security. This platform will have a goal of providing sufficient agricultural market information to participants in the agricultural markets to improve agricultural marketing services (government, producers, cooperatives, traders, transporters, processors, retailers, entertainment industry, and consumers).

Budget: Rwf 3.75 Billion

3. Mobile-Telephone Enabled Agriculture Technology Apps:

Budget: Rwf 3.75 Billion

Apps	Description	Benefits
e-Growers information Management System	It is the most ideal for managing small scale farmers by offering consolidated tool from planning, production to marketing by offering robust planning, monitoring & evaluation , alternatives and reporting tools. Ideally it forms a comprehensive knowledge databank of agriculture and its value chain. Some key features are: • Farmer Registration • Parameterization • Crop management • Animal management • Traceability • Cashless payments • Users Management • Agri loans application • Credit Scoring • Cloud based	1. Optimizing production by offering guide through efficient planning, knowledge, evaluation, alternatives etc. 2. Enabling financial inclusion by offering auto credit scoring 3. Facilitates payments via mobile money 4. Offers traceability and ensuring food safet to consumers as well as quality to producers translating to good prices in local and exports markets. 5. Provides a comprehensive KYC of player thus bring accountability 6. Allows data analytics and hence giving insights on market dynamics
e-Inputs	This is a solution to assist in the requisition, processing, dispatch scheduling as well as payment for inputs like;- • Fertilizers • Seeds • Animal feeds • Other Agriculture based Inputs & Machinery Some key features are: • USSD -accessed by use of any mobile phone running under any telecom service provider • Smart phone app - accessed through any smart phone • Cloud based web application	1. Ensures inputs reaches intended users in time 2. Ensures prices are regulated competitively 3. Provides credit reference on agri-lending 4. Real time data on inputs stock levels 5. Provides a mobile payment platform 6. Auto cr edit scoring the borrowing farmers 7. Ensures consolidated payments, reconciliation and settlements 8. Provides window for analytics on use and impact on inputs
e-Agri-Wallet	• Cashless payment system that allows tokens as value for exchange of commodities and services. • Ensures use for intended purposes at the recommended	1. Accelerate access to agri financing 2. Prevent cash misappropriation 3. Facilitate agri-loan repayment
e-Trace Dairy	• This an application to assist in management of traceability in the Dairy sector. • Basic records from farmers are gathered via mobile phone and more information at the collection point. Organoleptic (observatory) and lacto-tests results are fed in the system to provide traceability reports as well as production, quality and payment reports	1. Guarantees traceability , quality and food safety 2. Record keeping to farmers, cooperatives 3. Data analytics to the regulators enabling them to plan, monitor and regulate the industry 4. Provides real time production and payment to the players 5. Visibility of the sector by markets and hence more market 6. Helps financial institutions to participate in agri-financing
e-Information	• This is an interactive application that allows farmers to query on their subject of interest and as well disseminate information to masses on various agricultural matters. • Ideally a professionally build knowledge base database will be at the core and have the ability to auto respond as well as schedule different subject matters at the right time/seasons	• Mass training and hence capacity building and knowledge transfer • Exchange of ideas and helps diversification • Real time alerts on urgent information • Notification of due dates

5 RESEARCH & ICT4RAg STRATEGY

The Ministry shall work with academic and research institutions to incorporate strategic research to reduce the negative impact of agricultural production on the environment as well as linking this to appropriate technology solutions. In this context, the MINAGRI has the following aims:

- identify future challenges for agriculture;
- to distil objectives and solution domains based on ICT as they apply in primary agriculture;
- to determine further research and innovation (R&I) requirements;
- to create a vision for ICT in agriculture; and
- to develop recommendations for implementation.

The above aims are intended to serve as a reference for future planning of Research and Innovation.

5.1 Increasing Productivity

Significant growth in the Rwanda population will exacerbate climate change, degradation of our natural resources and energy shortages, with adverse effects on soil productivity and food production. The situation is further aggravated by the decrease in arable land due to urbanization and other uses such as bio-energy. Research and innovation requirements can help pave the way towards more- sustainable, more-efficient agricultural production systems. The research in ICT4ARAg concept combines several ICT solution domains for plant and animal production and farm management which contribute to the identified goals in order to meet the aforementioned challenges.

Producing more food from the same amount of land while reducing the environmental impact requires an intensification of production systems. The concept of sustainable or ecological intensification aims to increase yield with fewer inputs and adverse consequences. This calls for a set of multifaceted measures and developments that complement and interact with one other. This suggests three innovation path- ways: consumer-driven, technology-driven, and institutional -driven.

5.2 Role of Research in ICT4RAg

Automation solutions as well as ICTs including sensors, global positioning and decision-support systems can play a considerable role in the development of sustainable and efficient farming systems. Firstly, there is precision farming, which offers different technologies for assisting the farmer in improving efficiency, reducing labor costs and enhancing flexibility on the farm. Automatically collected information, for example, enables farmers to precisely dose fertilizers and pesticides or sow seeds and apply other inputs by controlling agricultural machines. Information and communication technologies permit the optimized application of inputs, thereby reducing the adverse impacts of agriculture on the environment. This can help to enhance efficiency in food production and obtain higher outputs for lower inputs. An increase in outputs has a positive effect on farmers' profits and competitiveness. When used in conjunction with other measures, precision farming can increase productivity and farm profitability while reducing environmental degradation and conserving natural resources. This win-win potential – production benefits and environmental benefits – is in line with the 'green growth' strategies.

The second role played by automation solutions and ICTs is the use of ICT platforms and processes to promote communication, information exchange and networking among stakeholders. ICT therefore plays an important role in consumer information, and potentially be used to promote the adoption of new techniques and best practice throughout the farming community.

The third role is the use of ICT to monitor land-use patterns. Applications include environmental databases for tracking the status of various indicators and impacts for sustainable environmental management, soil-erosion assessments, and inventories of cultivated land by slope, steepness and wetland.

Strategic research should help strengthen the international competitiveness of Rwanda farmers while reducing the negative impact of agricultural production on the environment. Furthermore, MINAGRI aims to facilitate the use of information and communication technologies by farmers, as a way of meeting future challenges.

Future research and technological development (RTD) must focus on coordinated, cross-thematic research approaches. Much effort will need to be put into networks where researchers from different disciplines can establish contacts and develop innovative ideas. Funding and research initiatives should stimulate interdisciplinary RTD comprising agronomics, engineering, computer science, economics and social sciences as well as Public-Private Partnerships.

By combining stakeholders' expertise, the public and private actors who maintain the basic farm data and who are familiar with advice and support to farmers must be involved in the integration of knowledge-based systems into farm-management systems. Public services shall play an important role by providing ICT for environmental regulation and subsidy administration

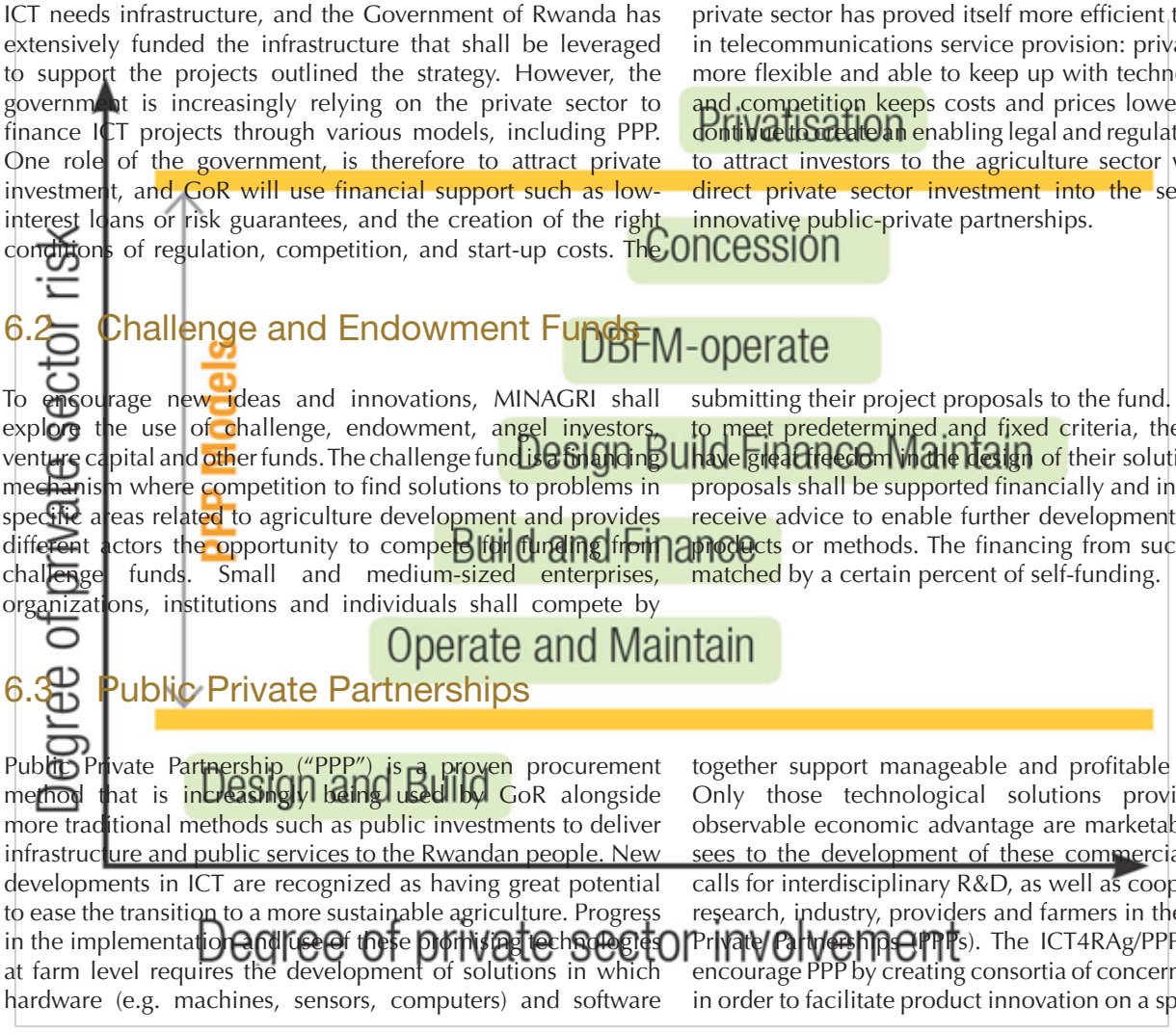
Given the many institutes, organizations and enterprises possessing substantial knowledge in the ICT4RAg sphere, there is significant potential in mobilizing research and innovation efforts. A helpful tool for cooperation in research initiatives will be developed by MINAGRI and other partners. The tool, an information platform with technical and social content, will be a structured framework for mapping and analyzing all relevant knowledge within ICT agriculture, as well as a central internet-based resource for researchers, developers and users. This tool should stimulate cooperation and coordination of R&D through user-driven initiatives and activities, leading to the pooling of fragmented human and financial resources. In this way, both the efficiency and the effectiveness of Rwanda's research efforts can be improved.

6. FINANCING ICT4RAg PROGRAMS, PROJECTS & INITIATIVES

The Government of Rwanda's massive investment in the ICT infrastructure over the last 15 years lays the necessary groundwork for private sector investment in ICT4RAg solutions required to support increased agricultural productivity. Further, by using a mix of incentives, regulation, policy interventions, and guidelines, the Government of Rwanda will continue to support the development and investment of ICT in Agriculture by the private sector and donors. Therefore, the expectation is a significant part of the budget shall be funded by the private sector, with donor support. The total budget associated with implementation of the Strategy over the next 5 years is Rwf 34 Billion.

6.1 Financing ICT Solutions and Infrastructure

ICT needs infrastructure, and the Government of Rwanda has extensively funded the infrastructure that shall be leveraged to support the projects outlined the strategy. However, the government is increasingly relying on the private sector to finance ICT projects through various models, including PPP. One role of the government, is therefore to attract private investment, and GoR will use financial support such as low-interest loans or risk guarantees, and the creation of the right conditions of regulation, competition, and start-up costs. The private sector has proved itself more efficient than government in telecommunications service provision: private providers are more flexible and able to keep up with technological change, and competition keeps costs and prices lower. The GoR shall continue to create an enabling legal and regulatory environment to attract investors to the agriculture sector whether through direct private sector investment into the sector or through innovative public-private partnerships.



6.2 Challenge and Endowment Funds

To encourage new ideas and innovations, MINAGRI shall explore the use of challenge, endowment, angel investors, venture capital and other funds. The challenge fund is a financing mechanism where competition to find solutions to problems in specific areas related to agriculture development and provides different actors the opportunity to compete for funding from challenge funds. Small and medium-sized enterprises, organizations, institutions and individuals shall compete by submitting their project proposals to the fund. While they have to meet predetermined and fixed criteria, the applicants will have great freedom in the design of their solution. The winning proposals shall be supported financially and in many cases also receive advice to enable further development and scale-up of products or methods. The financing from such funds shall be matched by a certain percent of self-funding.

6.3 Public Private Partnerships

Public Private Partnership ("PPP") is a proven procurement method that is increasingly being used by GoR alongside more traditional methods such as public investments to deliver infrastructure and public services to the Rwandan people. New developments in ICT are recognized as having great potential to ease the transition to a more sustainable agriculture. Progress in the implementation and use of these promising technologies at farm level requires the development of solutions in which hardware (e.g. machines, sensors, computers) and software together support manageable and profitable use by farmers. Only those technological solutions providing a clearly observable economic advantage are marketable, and industry sees to the development of these commercial products. This calls for interdisciplinary R&D, as well as cooperation between research, industry, providers and farmers in the form of Public-Private Partnerships (PPPs). The ICT4RAg/PPP action aims to encourage PPP by creating consortia of concerned stakeholders, in order to facilitate product innovation on a specific challenge.

One definition of innovation is the process of going "from an idea to a concrete product". All the links playing a part in this process constitute the 'value chain'. The 'value chain' analysis will provide the following: (1) A comprehensive overview of all components and actions needed to build the product and bring it to market; (2) A comprehensive list of all actors concerned at each link (e.g. developers, disseminators, research actors); (3) The opportunity for all stakeholder's actors to work together to deal with questions, subjects or difficulties that must be resolved in order to reach the final aim; and (4) Benefit from possible complementarities. Concrete products directly related to the market must be defined and validated in order to attract private actors to the PPP process.

By using PPPs, significant benefits in the quality of services and infrastructure can be delivered to the Rwandan population. Using the private sector to provide for public infrastructure, GoR can draw upon the best available private skills, knowledge and resources and therefore its public agencies can use the savings generated to improve or expand other public services.

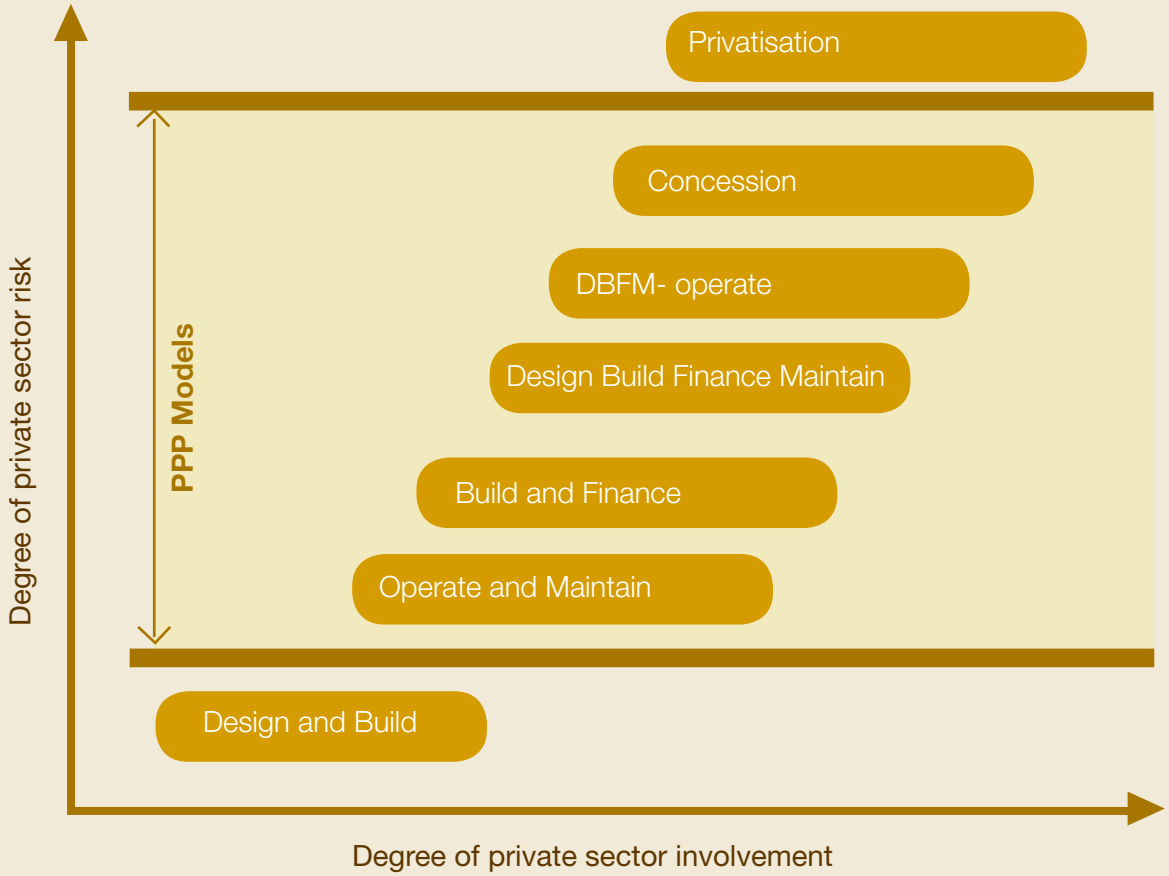


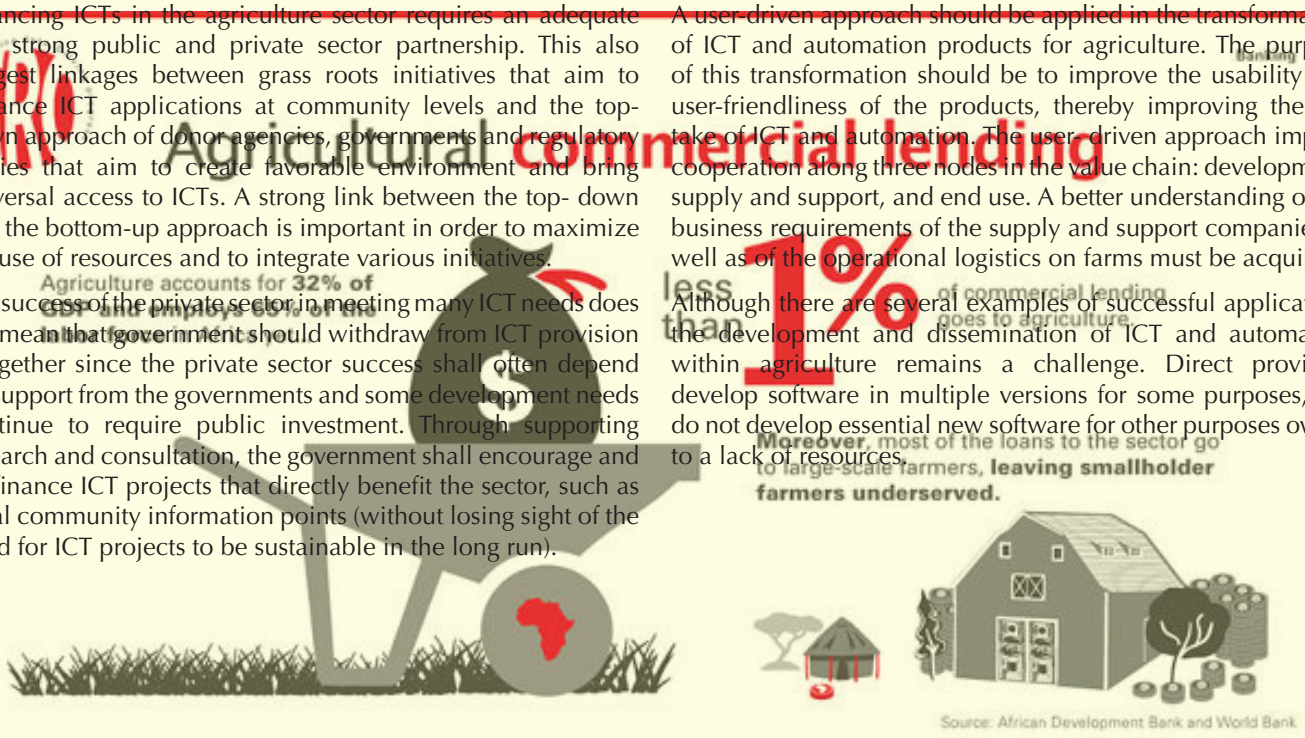
Fig 7: PPP MODELS

Financing ICTs in the agriculture sector requires an adequate and strong public and private sector partnership. This also suggest linkages between grass roots initiatives that aim to advance ICT applications at community levels and the top-down approach of donor agencies, governments and regulatory bodies that aim to create favorable environment and bring universal access to ICTs. A strong link between the top- down and the bottom-up approach is important in order to maximize the use of resources and to integrate various initiatives.

The success of the private sector in meeting many ICT needs does not mean that government should withdraw from ICT provision altogether since the private sector success shall often depend on support from the governments and some development needs continue to require public investment. Through supporting research and consultation, the government shall encourage and co-finance ICT projects that directly benefit the sector, such as local community information points (without losing sight of the need for ICT projects to be sustainable in the long run).

A user-driven approach should be applied in the transformation of ICT and automation products for agriculture. The purpose of this transformation should be to improve the usability and user-friendliness of the products, thereby improving the up-take of ICT and automation. The user- driven approach implies cooperation along three nodes in the value chain: development, supply and support, and end use. A better understanding of the business requirements of the supply and support companies as well as of the operational logistics on farms must be acquired.

Although there are several examples of successful application, the development and dissemination of ICT and automation within agriculture remains a challenge. Direct providers develop software in multiple versions for some purposes, but do not develop essential new software for other purposes owing to a lack of resources.



7. IMPLEMENTATION, MONITORING & EVALUATION

7.1 Introduction

The process of enhancing and embedding ICT in Agriculture is a long-term objective that requires continuous and rigorous planning, followed by innovative trials which are monitored and evaluated to feed into expansion and achieving concrete results. Appropriate monitoring and evaluation systems will be created for their optimal management to ensure desired results and sustainability. A detailed M&E Framework is appended as Annex 2 with sample templates that will be developed and used for monitoring and evaluating the impact of the ICT4RAg programs and projects.

7.2 Implementation

1. Are goals and objectives being achieved or not? If they are, then acknowledge, reward and communicate the progress. If not, then consider the following questions
   a. Will the goals be achieved according to the timelines specified? If not, why?
   b. Should the deadlines for completion be changed?
   c. Do personnel have adequate resources (money, equipment, facilities, training, etc.) to achieve the goals?
   d. Are the goals and objectives still realistic?
   e. Should priorities be changed to put more focus on achieving the goals?
   f. Should the goals be changed?
   g. What can be learned from monitoring and evaluation in order to improve future planning activities and also to improve future monitoring and evaluation efforts?

To meet ICT4RAg objectives, annual operating plans will be drawn up for activities at all levels. The Logical Framework Approach (LFA) will be used to describe the major program and projects and a log-frame matrix developed for each program and project. Activities and program that are already implemented or planned will be reviewed, and priorities will be defined, in line with the strategy.

Performance indicators will also be developed and program reviews will be conducted on a regular basis in order to evaluate the success and impact. The strategy plan will be updated regularly, in accordance with the results of the monitoring and evaluation processes.

7.3 Monitoring

Holistic and continuous monitoring processes will be carried out in order to attain two major goals: to monitor progress of the ICT4RAg Strategy in Agriculture activities and to enable partnerships by providing tools to agree on, track and adjust objectives and processes.

As part of the monitoring process, all ICT in Agriculture teams will produce and submit periodic reports on the progress of activities and financial statements. Indicators for the monitoring of activities will be developed at two levels. Quantitative and qualitative indicators will be developed to measure access to ICT in agriculture and the impact on agriculture productivity. Baseline indicators will be carried through to subsequent documents for precise results

7.4 Evaluation

Implementation teams will carry out regular evaluation of activities and program in order to ensure that they are adequate and have attained the set targets. A situation analysis will be conducted prior to the implementation of the activities and program in order to establish a baseline. Program documents will be reviewed on a quarterly basis to determine whether priorities should be adjusted. Long-term program will be reviewed at mid-course to ensure they are delivering results, in line with the stated objectives and targets.

7.5 Human Resources

ICT for Agriculture team and the MINAGRI management team will be staffed with appropriately qualified individuals in the areas of technology, agriculture, project management, monitoring and evaluation, infrastructure and research as required. Additional expertise (consultants from strategic partners) will also be sought for short-term missions as required. The overall ICT4RAg management shall under the Single Project Implementation Unit.

7.6 e-Agriculture Opportunities

Farmers need reliable, convenient, and sustainable solutions that address their challenges. As with other initiatives, the goal is to use technology to strengthen the local agricultural system and improve productivity for everyone in the agriculture value chain. eAgriculture projects could provide opportunities and benefits to a wide range of stakeholders, from small farmers to businesses and governments.

The process of enhancing and embedding **ICT in Agriculture** is a long-term objective that requires **continuous** and **rigorous planning**..

Fig 8. eAgriculture opportunities for stakeholders

Critical Success Factors

- Real economic value added either because of savings resulting from the use of ICT or an increase in revenue or profitability.
- Using a central project/program coordinating and empowered project implementation team to implement the projects
- Appropriate communication strategy that uses appropriate language and medium to communicate with the farmers and other stakeholders providing a good response to the programs
- Good conceptualization and execution by including multiple stakeholders in win–win partnerships.
- Building trust by using local champions as facilitators and locally developed solutions.
- Directly involve the community members in training and can demonstrating solutions

7.7 Recommendations

1. Strengthen partnerships with the relevant stakeholders.

Synergies between the different parties in the agricultural value chain need to be exploited optimally by setting up forums to encourage dialogue, interaction and promote knowledge related to use of ICT in agriculture. Specific partnerships should be identified and be built between stakeholders for identified ICT4RAg projects with targeted outcomes, working with established partners. These partnerships can play an invaluable role in the research, planning, problem solving, review of operations and in training relevant government officials and staff in the use of ICT in agriculture.

2. Enhance the management of the ICT4RAg Strategy

Leadership, communication and creative thinking are required to initiate and sustain ICT4RAg projects that will have a significant impact. A well structure, and resourced management and support structure would enable communication between private sector and government and drive the strategic national agenda.

3. Develop self-sustaining funding solutions

Since ICT4RAg ventures, particularly those taken up by communities, must be sustainable beyond their initial funding periods, it is necessary that strong business models exist and that the community members can benefit directly.

4. Focus on community ownership

Well-established community ownership assists projects to survive and reduce long-term dependency on an external champion. Thus, program designers and implementers of community-based projects should include community members in decision making early in the project and progressively hand over leadership and operation of the project to them. As community owned projects are often resource-scarce, it is best to adopt approaches that make adequate use of the existing infrastructure and resources.

5. Make ICT4RAg technology and solutions robust and accessible

Systems are only valuable if they are used, but this can only occur in ICT4RAg projects if the end users find the systems easy to use and the technology is cheap, available, reliable and can be run off-line when necessary. Systems designers and developers need to design system access through commonly available technology devices, such as mobile devices, and include alternative communication options in order to include the largest possible number of end users. Standards can grow out of recent and ongoing research projects, but it is essential to establish follow-up strategies to promote the application of the project results. Common communication standards will be an important incentive for improved interoperability of ICT and automation applications.

6. Encourage local job-creation

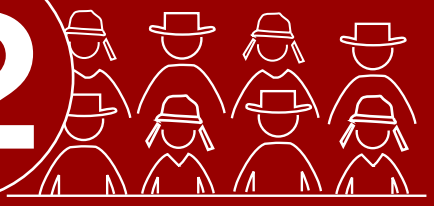
Some jobs related to ICT4RAg can be filled by local people and creating these jobs would address the rural brain drain to some small extent. This mean that the plan must be viable by making project self-funding as one of the projects' evaluation criteria by intentionally designing an exit strategy from the beginning. This could be by creating separate, independent local organizations in each area where the projects are implemented. These local organizations should have their own management structures with support from the central coordinating agency. By design, this support is removed gradually over time as local projects begin to be able to carry their own weight.The skills to be imparted to the local leaders include learning to understand the needs of communities, how to analyze solutions that are working or not working in other areas, and how to synthesize ideas to develop effective and long-lasting solutions in the communities.

Key Performance Indicators (2016-2020)

KPI # 1

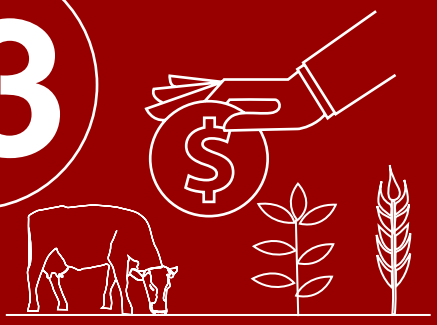
Increase lending to smallholder farmers from **2%** of total lending by commercial banks to **10%**

KPI # 2



Register **2 million** farmers countrywide from current **300,000** farmers in 2015 in a centralized, accessible, and secure database

KPI # 3

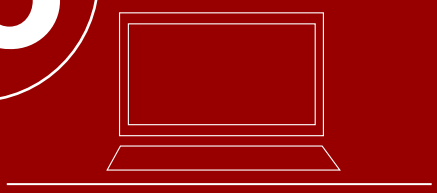


Increase private sector investment in agriculture from **5%** to **15%**

KPI # 4

Launch **5** new e-agriculture apps each year

KPI # 5



Digitize all agriculture related knowledge material and make it available online and mobile telephone.

CONCLUSION

The key to the role of ICTs in the agricultural context is in bridging information gaps. Information is vital for rural people to be able to make informed decisions on the critical issues they face. There are a number of key areas where this information is needed – related to specific agricultural value chains, increasing resilience by managing the risk of crop and animal diseases and pests, and those which help farmers to maximize their income, both by improving production through technical advisory services, and by increasing income through market price information, access to financial services and improved market linkages.
The targeted benefits of ICT4RAg Strategy for the improvement and strengthening of agriculture sector are:

- Timely information on weather forecasts and calamities;
- Better and spontaneous agricultural practices;
- Better marketing exposure and pricing;
- Reduction of agricultural risks and enhanced incomes;
- Better awareness and information;
- Improved networking and communication, and
- Facility of online trading and e-commerce.

There is a "Digital Divide" that is hindering the capacity and productivity of rural agricultural activities carried out by the farmers in Rwanda, but the situation can improve if attention is paid towards the following capacity development initiatives:

- Simple and farmer friendly solutions, regulations, policy and reforms;
- Fixing of accountability of persons/institutions dealing with farmers;
- Representation of farmers in various matters affecting them; and
- Providing of technical assistance to microfinance/ micro-credit institutions to build their agro-lending capabilities and capacities, and improved managerial and operational capacities,

The success of the ICT4RAg requires new technologies, improved management structures, new institutional responses, "collective expertise" and an "ideal public-private partnership" base. It also needs creative and imaginative solutions that increase agricultural productivity, increase farm incomes, increase food production etc. Institution building, capacity building, empowering farmers through investment in their capabilities, etc. are the kind of initiatives required. It is only by intensive and modernization of agriculture and promoting agro-industries that maximize the potential to provide new avenues of employment to the rural population in Rwanda.

The ICT4RAg Strategy 2016 -2020, is ambitious but remains consistent with the reality, infrastructure, resources and capacity required to implement. The Strategy shall guide the efforts to expand and optimize the role of ICT in agriculture and manage the journey to achieve the mission, vision and objectives of the Ministry of Agriculture and Animal Resources.

Referenced documents	
Title of Document	**Published Date**
Rwanda National Strategic Vision 2000 - 2020	2000
Economic Development and Poverty Reduction Strategy (2013 – 2018) Shaping Our Development	2013
National Information and Communication Infrastructure Plans (NICI I, II, III)	2000, 2006, 2010
7 Year Government Program (2010 -2017)	2010
ICT Sector Strategic Plan (2013-2018)	2013
SMART Rwanda Master Plan 2016 - 2020	2015
Strategic Plan for the Transformation of Agriculture – Phase 1, 2 and 3 (SPAT I, II,II)	2004, 2009, 2013
Rwanda Cyber Security Policy	2015
PPP Law (Draft)	2015
PPP Policy (Draft)	2015

Annex 1: ICT4RAg Solution Developers & Service Providers Guidelines

1. Introduction

Rwanda is a largely an agrarian economy that intends to become a knowledge based economy by using ICT Solutions to address existing and emerging challenges of Rwanda's agricultural sector.

In that context, the Ministry of Agriculture and Animal Resources (MINAGRI) is encouraging different partners in agriculture who are willing to develop ICT solutions for agricultural related challenges.

A number of ICT4RAg products have often been developed by K-Lab members, individual IT developers, students from high schools and even in ICT4Ag hackathon events, but most of them hardly move out of the concept stage to real world application. MINAGRI is therefore striving to work with the private companies or individuals to make sure that these solutions add value to the agricultural sector. MINAGRI receives significant number of proposals for e-agriculture solutions but often these solutions lack robust business cases, with detailed cost benefit analysis, adherence to standards and best practice norms. Therefore, this annex document serves as guideline for ICT solution development framework and defines the partnership between MINAGRI and ICT4Rag solution and service providers. It is hoped that the document will allow for clarity and structure that will provide support for all ICT4RAg practitioners. In doing this, MINAGRI will be also contributing to youth empowerment and job creation.

1.1 Definition of ICT4RAg Terminology

Why ICT4RAg?

Information and communication technologies (ICTs) have a transformative influence on farming and food production in countries where governments and policy makers are committed to developing comprehensive e-agriculture strategies. ICT4RAg can therefore be defined as the ability of ICTs to accelerate agricultural performance in light of rising investments in agricultural sector across the value chain. This is supported by the increasing private sector strong interest in the development and spread of ICTs, and the increase of organizations committed to the agricultural development agenda..

What is e-Agriculture?

E-Agriculture is an emerging field focusing on the enhancement of agricultural and rural development through improved information and communication technologies processes.

When does an ICT Solution fit into ICT4RAg?

An ICT solution is considered as ICT4RAg solution if it contributes to agricultural value chains development and play a significant role in boosting agricultural sector and rural development. That means applications focusing on:

- Solutions complete traceability of production, products and service through a networked value chain including logistics
- Collaborative environment and trusted sharing of knowledge and supporting innovation in agro-processing
- Solutions supporting the management of natural resources and rural environment

1.2 Objectives and purposes of the guideline

Objectives

- To guide ICT4Ag practitioners on the requirements from the Ministry regarding ICT4RAg solutions to be developed and monitoring progress.
- To provide guidance on issues that respond to the existing gaps in the agricultural sector for effective and efficient development of working solutions.
- To promote the public and private partnerships involvement in developing and implementing appropriate ICT4RAg solutions that will speed up the process of agricultural transformation.
- To promote investment in human capital training and research, matching available and innovative IT solutions to the end-user needs and their involvement.

Purposes

1. To provide the framework for partnership between MINAGRI and private sector in ICT4RAg adoption for agricultural value development.
2. To define the role MINAGRI is expected to play in order to facilitate the private sector involvement in development and deployment of ICT4RAg solutions by establishing a link with other government institutions in the agricultural sector.
3. To establish parameters for negotiating (between owner of the solution and MINAGRI) the cost of the service benefiting both end user and owner of the solution before deployment;
4. To encourage the orderly development of ICT4RAg systems and implementation and avoid duplication of effort through harmonization of standards and process for undertaking ICT4RAg solution development.
5. To prevent any discrimination in the provision of ICT4RAg Services/solution and promote and maintain co-operation and fair competition between ICT4RAg practitioners.

2. Essential requirements for ICT4RAg development

2.1 Important requirements for ICT4RAg Development

1. **Partnerships to ensure positive impacts of ICT4Ag initiatives:** ICTs for agriculture initiatives are developed in isolation, with companies and individuals producing comparable applications (apps) for similar purposes. Those involved in ICT development should build partnerships and communities of practice that encourage greater collaboration. They should also build on existing models and approaches to develop solutions that have a real impact.
2. **ICTs for extension and advisory services:** Providing high quality information to farmers and vice versa is very important.
3. **Supporting open and big data for smallholder farmers:** The importance of good data visualization, and the importance of providing real-time data via multiple channels to smallholders and others involved in value chains have to be taken into account
4. **Ensuring the reliability and availability of high-quality information:** Develop farmers' trust in ICT services by providing high-quality solutions that demonstrate benefits early in the implementation process.
5. **Ensuring grassroots access to ICT solutions:** Many rural communities still have little or no access to ICTs. It is needed to ensure that they can take advantages of these technologies, in terms of cost, availability and usability.
6. **Involvement of young people and women in ICT4RAg initiatives** - ICTs have an important role to play in empowering young people and women. This may have to be considered also in ICT adoption for agricultural transformation.
7. **ICT4RAg entrepreneurship and promising business models:** Entrepreneurs have to develop sound business models to ensure that their apps are likely to survive and can be scaled upwards for wider use.
8. **Sound strategies and high-level political buy-ins for ICT4RAg:** Considering the e-agriculture strategies or ICT4AG strategies that are in place to support the efficiency and effectiveness use of ICTs for agriculture.
9. **Adequate infrastructure and energy for ICTs in rural areas**: Solutions need to consider the infrastructure such as broadband infrastructure, mobile phone masts, energy provision that are very important.
10. **Sound knowledge management activities:** In addition to above requirement, there is need to address issues like awareness-creation, information-gathering and capacity-building on ICT4RAg. So, the need for more inclusive learning models that promote the existence of ICT4Ag knowledge providers at grassroots level using the value chain model need also be taken into consideration.

3. ICT Solution Architecture for Agriculture

ICTs in agriculture have the potential to facilitate greater access to information that drive or support knowledge sharing. ICTs essentially facilitate the creation, management, storage, retrieval, and dissemination of any relevant data, knowledge, and information that may have been already processed and adapted. Figure 1 presents a model to address these properties.

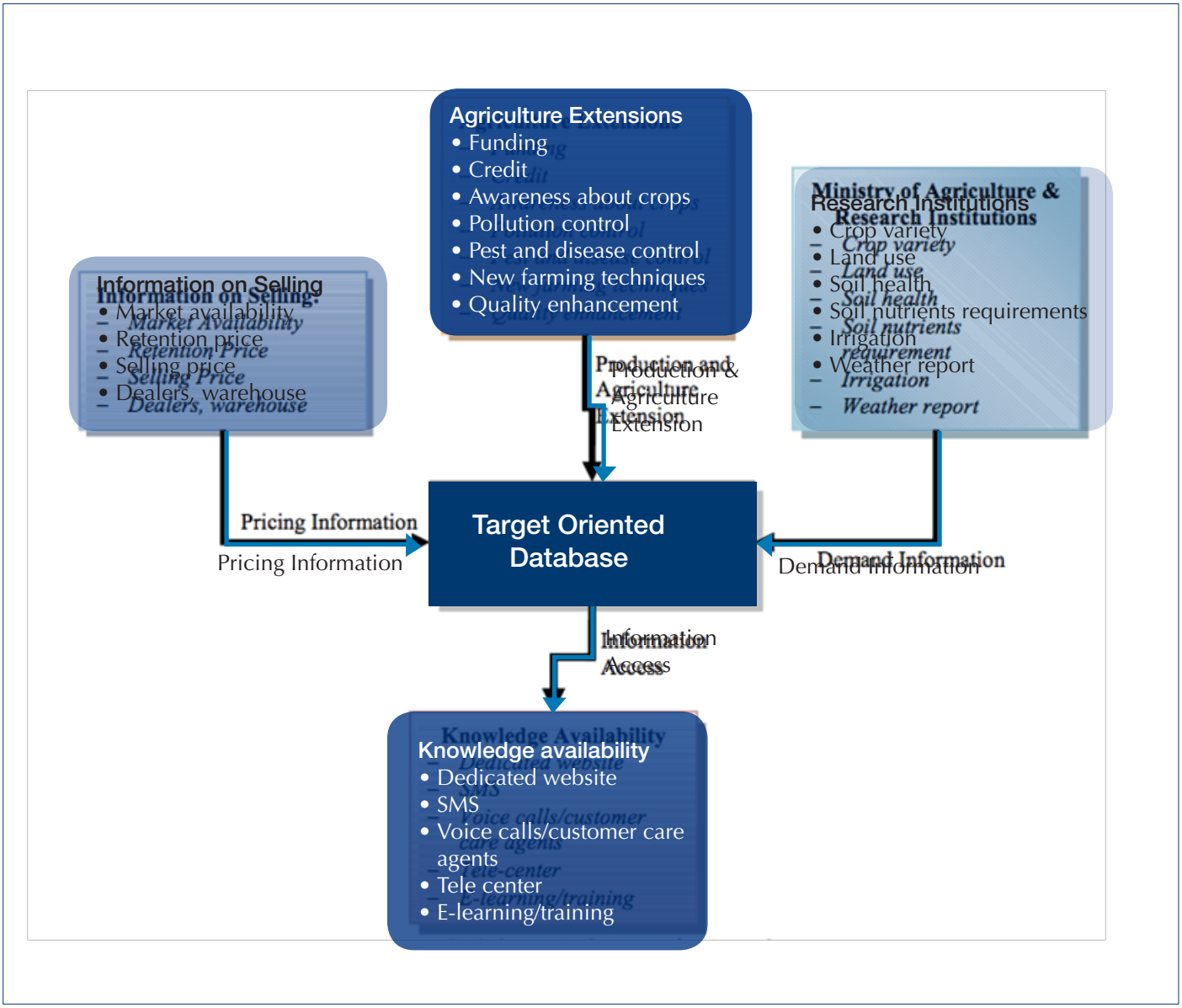


Fig 1. ICT Solution Architecture for Agriculture

In this model, tools for specific applications to meet the demand of the farmers are developed. Such tools must avail the data to the database in a format that can be easily integrated and accessed by the farmers on demand. The tools here could be research systems, geographical systems, development of knowledge based systems, decision support system etc. These tools are also used by researchers and scientists to develop new technologies and innovations. Examples of such include drought resistant seeds, irrigation strategies for water management, participatory animal and plant pest and disease monitoring and surveillance among others.

4. Partnering with MINAGRI Specific Requirements

A developer of ICT4RAg solutions (either private company or individuals) wishing to work with MINAGRI, will need to provide the following:

- Letter requesting the partnership or any other specified support from the Ministry
- Concept note specifying the following :

1. Description of the company or individual requesting for the partnership
2. The description of the proposed solution (IT solution), and how it is contributing or building to the existing related initiatives. If the solution is a final product of a feature / prototype
3. Target segment of the agriculture value chain.
4. The value addition that the solution will bring to the sector (agricultural sector).
5. Benefit to the MINAGRI and its institutions, the target group and the developers themselves for ensuring the system/ solution sustainability
6. Status of intellectual property rights if acquired from RDB or other statements showing originality of solution.
7. Rollout document with clear implementation and communication strategy to make sure that the end user, especially farmers understand well the solution/s, what it brings and what is required of them.

- Recommendation letter from PSF – ICT Chamber: The company / individual may have to be registered in PSF/ICT chamber as a member of one its associations.
    - A recommendation letter from the president of the chamber will be presented to the Ministry of Agriculture & Agriculture Resources for the request of partnership.
- Business Model as a document for the successful operation of a business and sustainability, indicate source/s of revenue, the intended customer base, products, and details of financing mechanisms etc.

4.1 MINAGRI will assess the request and shall inform the requesting party in writing within maximum **Ten (10) working days** after receipt of the application confirming, if:

- The solution is eligible, not conflicting and duplicating with other solutions in place; or
- The system is not eligible for partnership – either conflicting with others or need some modification before either developing it or scaling it up

4.2 If eligible, the process of defining the working framework will commence and completed within 10 working days from successful application.

4.3 If not eligible, the company/firm or an individual will be advised to adjust or change the proposal totally.

5. Support from the Ministry / Partnership with the Ministry

For companies that qualify for a partnership with the Ministry of Agriculture and Animal Resources there 3 ways of partnership:

a) Certificate of Recognition ,
b) Memorandum of Understanding, or
c) Contract with Developers

5.1 Certificate of Recognition,

MINAGRI shall according to the application of the solution/service provider assess the request and provide a support note, recommendation letter or certificate of recognition as an ICT provider to the Agriculture sector. That support note will play a role of supporting that company to approach other partners in the agricultural sector for collaboration in the solution development or deployment.

5.2 MoU – Memorandum of Understanding

In this context, both MINAGRI and the solution/service provider shall sign a Memorandum of Understanding with clear roles and responsibilities for each signatory.

5.3 Service Provider Contract

In cases where the request requires any form of cost sharing that involves the Ministry to dispense financial resources, the ministry will examine options for engagement that may include using the government procurement process. As such the Ministry will require the private company to consent to the forfeiting of confidentiality as government procurement requirements demand its agencies to adhere to transparent practices and so the ministry cannot engage in a closed negotiation with just one provider. Where applicable, the Ministry may also evaluate the option of single sourcing.

Note: For companies or individuals that do not need any support from MINAGRI but have ICT4RAg solutions responding to the agricultural challenges, they shall be nevertheless required to register their solution with PSF-ICT Chamber to avoid duplication since the Chamber will regularly update the Ministry with the list of ICT4RAg solutions both in progress or currently deployed by the private sector. This shall also apply for Non-Government Organizations and Civil Society Organizations that while don't qualify as private sector entities but may be offering ICT Solutions to the Agriculture sector. The purpose of this effort is to have a clear view of what solutions are existing, where the gaps are still existing.
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Review of the Guidelines

These guidelines shall be reviewed periodically to confirm whether they deliver the desired level of collaboration and clarity required to meet the needs of the agricultural sector or fit the purpose of partnership.

6. Confidentiality

MINAGRI will ensure that information sent by ICT4RAg solution and services providers will be treated in confidence and the information shall not be passed to any other company where such information may provide unfair competitive advantage or infringe IP rights.

7. Effectiveness

These guidelines shall become effective from the date of signature and publication by MINAGRI.

Annex 2: ICT4RAg Monitoring & Evaluation Guidelines

Why is M&E important?

A well-functioning M&E system is a critical part of good project/program management and accountability. Timely and reliable M&E provides information to:

- Support project/program implementation with accurate, evidence based reporting that informs management and decision-making to guide and improve project/program performance.
- Contribute to organizational learning and knowledge sharing by reflecting upon and sharing experiences and lessons so that the institution can gain the full benefit from the what and the how.
- Uphold accountability and compliance by demonstrating whether or not work has been carried out as agreed and in compliance with established standards and with any other donor requirements.
- Provide opportunities for stakeholder feedback, especially beneficiaries, to provide input into and perceptions of the work, modelling openness to criticism, and willingness to learn from experiences and to adapt to changing needs.
- Promote and celebrate the work done by highlighting accomplishments and achievements, building morale and contributing to resource mobilization

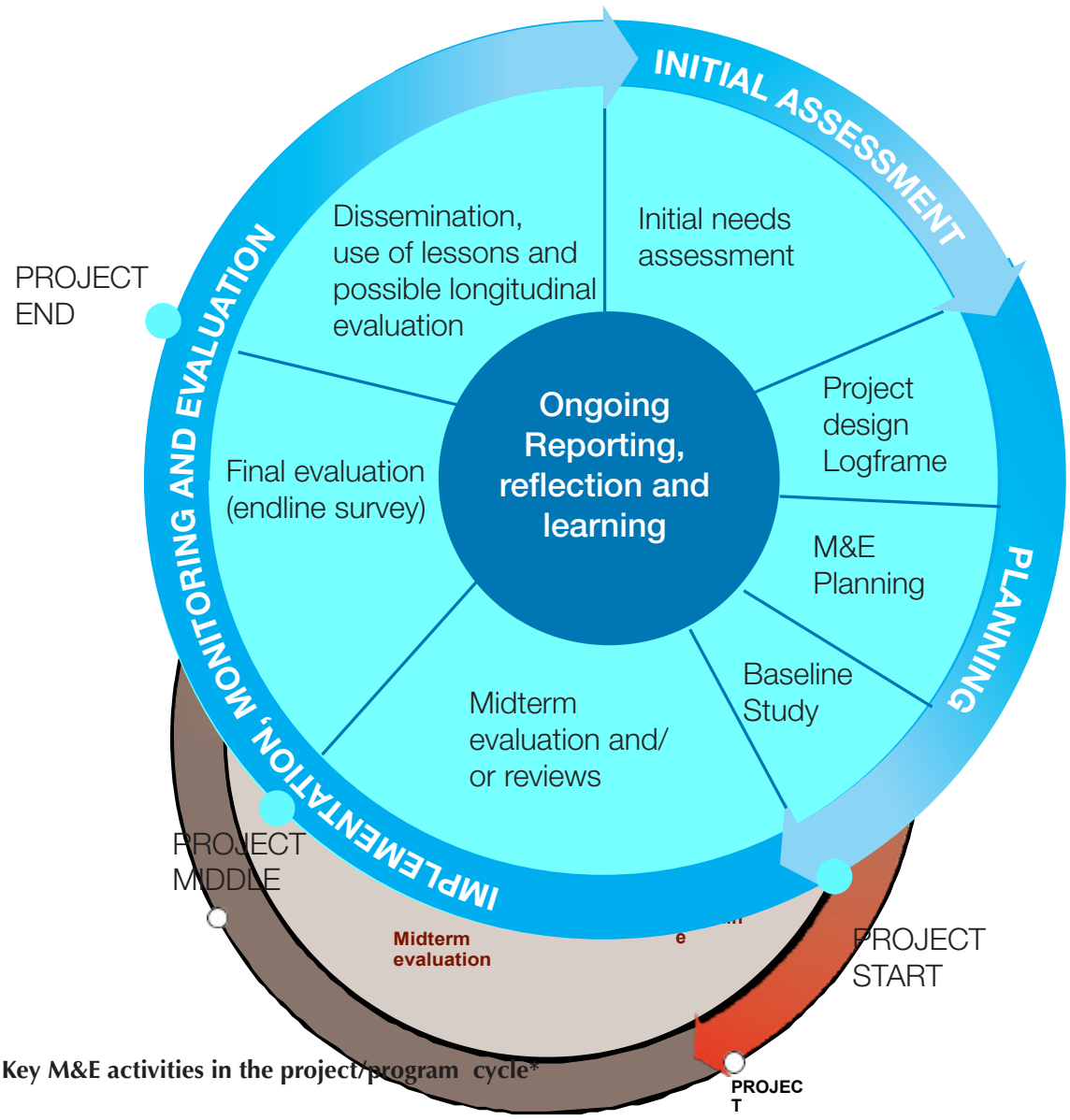

Fig **1. Key M&E activities in the project/program cycle***

Planning, Monitoring, Evaluation and Reporting activities include

1. Initial needs assessment. This is done to determine whether a project/program is needed and, if so, to inform its planning.
2. Logframe and indicators.This involves the operational design of the project/ program and its objectives, indicators, means of verification and assumptions.
3. M&E planning. This is the practical planning for the project/program to monitor and evaluate the logframe's objectives and indicators.
4. Baseline study. This is the measurement of the initial conditions (appropriate indicators) before the start of a project/program.
5. Midterm evaluation and/ or reviews.These are important reflection events to assess and inform ongoing project/program implementation
6. Final evaluation. This occurs after project/program completion to assess how well the project/program achieved its intended objectives and what difference this has made.
7. Dissemination and use of lessons.This informs ongoing programming. However, reporting, reflection and learning should occur throughout the whole project/programcycle, which is why these have been placed in the center of thediagram.

Monitoring

Monitoring is the routine collection and analysis of information to track progress against set plans and check compliance to established standards. It helps identify trends and patterns, adapt strategies and inform decisions for project/program management.

Fig 2 summarizes key monitoring questions as they relate to the log- frame's objectives. They focus more on the lower-level objectives – inputs,activities and (to a certain extent) outcomes.This is because the outcomes and goals are usually more challenging changes (typically in knowledge, attitudes and practice/behaviors) to measure, and require a longer time frame and a more focused assessment provided by evaluations.

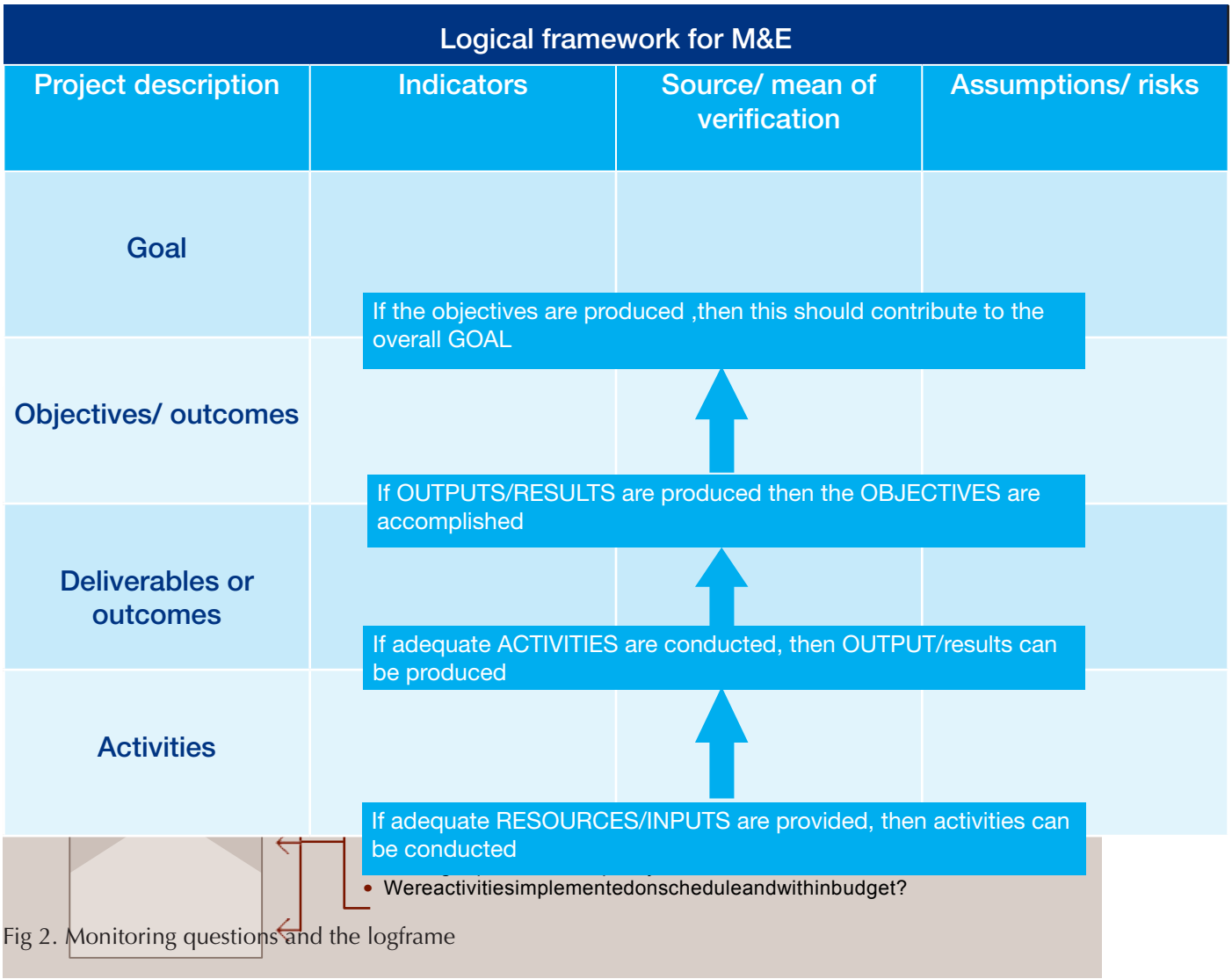

Fig 2. Monitoring questions and the logframe

A project/program usually monitors a variety of things according to its specific informational needs.Table1 provides a summary of the different types of monitoring commonly found in a project/program monitoring system. It is important to remember that these monitoring types often occur simultaneously as part of an overall monitoring system.

TABLE 1: Common types of monitoring
Results monitoring tracks effects and impacts. This is where monitoring merges with evaluation to determine if the project/ program is on target towards its intended results (outputs, outcomes, impact) and whether there maybe any unintended impact (positive ornegative).For example, amarket information system delivers accurate reliable and timely information that the famer can rely on and contribute to better decision making.
Process (activity) monitoring tracks the use of inputs and resources, the progress of activities and the delivery of outputs.It examines how activities are delivered–the efficiency in time and resources.It is often conducted in conjunction with compliance monitoring and feeds into the evaluation of impact. For example, a water and sanitation project may monitor that targeted households receive septic systems according to schedule.
Compliance monitoring ensures compliance with donor regulations and expected results, grant and contract requirements, local governmental regulations and laws,and ethical standards.For example, a database systems may be monitored to ensure that it adheres to agreed national and international technical standards in development.
Context (situation) monitoring tracks the setting in which the project/program operates, especially as it affects identified risks and assumptions, but also any unexpected considerations that may arise. It includes the field as well as the larger political, institutional ,funding, and policy context that affect the project / program .
Beneficiary monitoring tracks beneficiary perceptions of a project/program. It includes beneficiary satisfaction or complaints with the project/program, including their participation, treatment, access to resources and their overall experience of change.Sometimes referred to as beneficiary contact monitoring (BCM), it often includes a stakeholder complaints and feedback mechanism. It should take account of direct beneficiaries, as well as the perceptions of indirect beneficiaries(e.g.community members not directly receiving a good or service).
Financial monitoring accounts for costs by input and activity within predefined categories of expenditure. It is often conducted in conjunction with compliance and process monitoring. For example, a project implementing a series of services may monitor the project to ensure implementation is according to the budget and timeframe.
Organizational monitoring tracks the sustainability, institutional development and capacity building in the project/program and with its partners. It is often done in conjunction with the monitoring processes of the larger, implementing organization. For example, a SPIU may use organizational monitoring to track communication and collaboration in project implementation at the district level.

There are various processes and tools to assist with the different types of monitoring, which generally involve obtaining, analyzing and reporting on monitoring data. Specific processes and tools may vary according to monitoring need, but there are some overall best practices, which are summarized below.

Monitoring best practices
• Monitoring data should be well-focused to specific audiences and uses (only what is necessary and sufficient). • Monitoring should be systematic, based upon predetermined indicators and assumptions. • Monitoring should also look for unanticipated changes with the project/ program and its context, including any changes in project/program assumptions/risks; this information should be used to adjust project/pro- gram implementation plans. • Monitoring needs to be timely, so information can be readily used to in- form project/program implementation. • Whenever possible, monitoring should be participatory, involving key stakeholders this cannot only reduce costs but can build understanding and ownership. • Monitoring information is not only for project/program management but should be shared when possible with beneficiaries, donors and any other relevant stakeholders.

Framework for Evaluation

Proper management of an evaluation is a critical element for its success. There are multiple resources to support evaluation management. Most important is the Framework for Evaluation which identifies the key criteria and standards that guide how to plan, commission, conduct, report on and utilize evaluations.The framework is to be applied to all evaluation activities and to guide evaluations throughout the ICT4RAg implementation duration. It draws upon the best practices from the international community to ensure accurate and reliable evaluations that are credible with stakeholders. Table 2, summarizes the criteria and standards from the ICT4RAg Framework for Evaluation.

TABLE 2: The ICT4RAg framework for evaluation – criteria and standards

Evaluation criteria guide onwhat to evaluate the project	Evaluation standards guide on how to evaluate the project
Standards and policies. The extent that the project upholds the policies and guidelines of the Ministry of Agriculture & Animal Resources. **Relevance and appropriateness.** The extent that the project/ program work is suited to the needs and priorities of the target group and complements work from other stakeholders. **Efficiency.** The extent that the project/program is cost-effective and timely. **Effectiveness**. The extent that the project/program has or is likely to achieve its intended, immediate results. **Coverage**. The extent that the work includes(or excludes)any population groups and the differential impact on these groups. **Impact.** The extent that the project/program affects positive and negative changes on stakeholders, directly or indirectly, intended or unintended. **Coherence.** The extent that the project/program is consistent with relevant policies and takes adequate account of farmer's considerations. **Sustainability and connectedness.** The extent the benefits of the project/ program are likely to continue once the implementation team role is completed.	**Utility**. Evaluations must be useful and used. **Feasibility.** Evaluations must be realistic, diplomatic and managed in a sensible, cost- effective manner. **Ethics and legality**. Evaluations must be conducted in an ethical and legal manner, with particular regard for the welfare of those involved in and affected by the evaluation. **Impartiality and independence**. Evaluations should provide a comprehensive and unbiased assessment that takes into account the view so fall stakeholders. With external evaluations, evaluators should not be involved or have a vested interestin the intervention being evaluated. **Transparency.** Evaluation activities should reflect an attitude of openness and transparency. **Accuracy.** Evaluations should be technically accurate, providing sufficient information about the data collection, analysis and interpretation methods so that its worth or merit can be determined. **Participation.**Stakeholders should be consulted and meaningfully involved in the evaluation process when feasible and appropriate. **Collaboration.** Collaboration between key operating partners in the evaluation process improves the legitimacy and utility of the evaluation.

Key reminders for all M&E steps:

- The M&E steps are interconnected and should be viewed as part of a mutually supportive M&E system. Identifying separate steps to help organize and guide the discussion. In reality, these steps are not necessarily separate, but interrelated, often happening simultaneously. For example, what data is collected will largely depend on the data needed to be reported – one step is integral tothe other step and would be planned at the same time.
- M&E planning should be done by those who use the information. Involvement of project/program staff and key stakeholders ensures feasibility, understanding and ownership of the M&E system. M&E planning should not be limited to a headquarters' office, but informed by the realities and practicalities of the field. The leadership of an experienced project/program manager, ideally experienced in M&E, is very helpful to ensure M&E activities are well adapted and within the project/program's time frame and capacity.
- Planning for the M&E system should commence immediately after the project/program design stage (see Diagram 1). Early M&E planning allows for preparation of adequate time, resources and personnel before project/program implementation. It also informs the project/program design process itself as it requires people to realistically consider how practical it is to do everything theyintend to measure. Sometimes, the timing of the M&E planning is determined by donor requirements (e.g. at the proposal stage), and additional M&E planning may occur after a project/program is approved and funded.
- A project/program M&E system builds upon the initial assessment and project/program design. It is based on the short-term, intermediate and longterm objectives and their indicators identified in the project's logframe, the informational requirements and expectations of stakeholders, as well as other practical considerations, such as project/program budget and time frame.
- When appropriate, it is useful to build on existing M&E capacities and practices.
- New M&E processes may not only burden the local capacity but they can alienate local stakeholders. If existing M&E practices are accurate, reliable and timely, this can save time/resources and build ownership to coordinate with and complement them.
- Particular attention should be given to stakeholder interests and expectations throughout the M&E process. This is a key consideration throughout all M&E steps). In addition to local beneficiaries, it is also important to coordinate and address interests and concerns from other stakeholders.
- Often, multiple actors may be involved in delivering programs either multilaterally, bilaterally or directly.
- M&E should be tailored and adjusted to the real-world context throughout the project/program's life cycle. Projects/program operate in a dynamic setting,and M&E activities need to adapt accordingly. Objectives may change,as will the M&E system as it refines its processes and addresses arising problems and concerns. Like a project/program itself, the M&E system should be monitored, periodically reviewed and improved upon.
- Only monitor and evaluate what is necessary and sufficient for project/program management and accountability. It takes time and resources to collect, manage and analyze data for reporting. Extra information is more often a burden than a luxury. It can distract attention away from the more relevant and useful information. It can also overload and strain a project/program's capacity and ability to deliver the very services it is seeking to measure!

Table 3: CHECKLIST – 6 key steps for project/program M&E

STEP 1: Identify the purpose and scope of the M&E system

Activities

- Review the project/program's operational design (logframe)
- Identify key stakeholder informational needs and expectations
- Identify any M&E requirements
- Scope major M&E events and functions

Key tools

- Refer to the project/program logframe
- M&E stakeholder assessment table
- M&E activity planning table

STEP 2: Plan for data collection and management

Activities

- Develop an M&E plan table
- Assess the availability of secondary data
- Determine the balance of quantitative and qualitative data
- Triangulate data collection sources and methods
- Determine sampling requirements
- Prepare for any surveys
- Prepare specific data collection methods/tools
- Establish stakeholder complaints and feedback mechanisms
- Establish project/program staff/volunteer review mechanisms
- Plan for data management
- Use an indicator tracking table(ITT)
- Use a risk log(table)

Key tools

- M&E plan table template and instructions
- Key data collection methods and tools
- Complaints form
- Complaints log
- Staff/volunteer performance management template
- Individual time resourcing sheet
- Project/program team time resourcing sheet
- Indicator tracking table (ITT)
- Risklog

STEP 3: Plan for data analysis

Activities

Develop a data analysis plan, identifying the:

- Purpose of data analysis
- Frequency of data analysis
- Responsibility for data analysis
- Process for data analysis

Follow the key data analysis stages:

- Data preparation
- Data analysis
- Data validation
- Data presentation
- Recommendations and action planning

STEP 4: Plan for information reporting and utilization

Activities

Anticipate and plan for reporting:

- Needs/audience
- Frequency
- Formats
- People responsible

Plan for information utilization:

- Information dissemination
- Decision-making and planning

Key Tools

- Reporting schedule
- Project/ program management report - template and instructions
- Decision log
- Action log
- Lessons learned log

STEP 5: Plan for M&E human resources and capacity building

Activities

- Assess the project/program's HR capacity for M&E
- Determine the extent of local participation
- Determine the extent of outside expertise
- Define the roles and responsibilities for M&E
- Plan to manage project/program team's M&E activities
- Identify M&E capacity-building requirements and opportunities

Key Tools

- Example M&E job description
- M&E training schedule

STEP 6: Prepare the M&E budget

Activities

- Itemize M&E budget needs
- Incorporate M&E costs into the project/program budget
- Review any donor budget requirements and contributions
- Plan for cost contingency

Table 4: ICT4RAg logframe– definition of terms			
OBJECTIVES (What we want to achieve)	**INDICATORS (How to measure change)**	**MEANS OF VERIFICATION (Where/how to get information)**	**ASSUMPTIONS (What else to be aware of)**
Goal The long-term results that an intervention seeks to achieve, which may be contributed to by factors outside the intervention	**Impact indicators** Quantitative and/or qualitative criteria that provide a simple and reliable means to measure achievement or reflect changes connected to the goal	How the information on the indicator will be collected (can include who will collect it and how often)	External conditions necessary if the goal is to contribute to the next level of intervention
Outcomes The primary result(s) that an intervention seeks to achieve, most commonly in terms of the knowledge, attitudes or practices of the target group	**Outcome indicators** As above, connected to the stated outcomes	As above	External conditions not under the direct control of the intervention necessary if the outcome is to contribute to reaching intervention goal
Outputs The tangible products, goods and services and other immediate results that lead to the achievement of outcomes	**Output indicators** As above, connected to the stated outputs	As above	External factors not under the direct control of the intervention which could restrict the outputs leading to the outcomes
Activities The collection of tasks to be carried out in order to achieve the outputs	**Process indicators** As above, connected to the stated activities	As above	External factors not under the direct control of the intervention which could restrict progress of activities

TABLE 5: ICT4RAg M&E Stakeholder Assessment					
Who	**What**	**Why**	**When**	**How (format)**	**M&E Role/ Function**
Project management	Project reports	Decision- making and strategic planning	Monthly	Indicator tracking table, quarterly project reports, annual strategic reports	Manage M&E system
Project staff	Project reports	Understand decisions and their role in implementation	Monthly	Weekly field reports, indicator tracking table and quarterly project reports	Collect monitoring data – supervise community members in data collection
Headquarters	Annual project information	Organizational knowledge sharing, learning and strategic planning	Annual	Federation-wide reportingsystem format	Review and feedback on report
Donor	Donor progress reports	Accountability to stated objectives	Quarterly	Donor reporting format based on indicator tracking table and quarterly project reports	Review and feedback on report
Communities (beneficiaries)	Community monitoring checklist	Accountability, understanding and ownership	Monthly	Community monitoring checklist	Monthly collect and report on project data in checklist
Implementing (bilateral) partner	Project reports	Accountability, collaboration, knowledge sharing and conserve resources	Monthly	Quarterly project reports with feedback form	Review and supplement project report narrative with feedback/ input
Local partner	Annual project information	Knowledge sharing, learning, promotion and support	Annual	Format based on indicator tracking table and quarterly project reports	Review and feedback on report
Local authority	External progress reports	Accountability, understanding and support	Quarterly	Format based on indicator tracking table and quarterly project reports	Review and feedback on report
Government	Donor/ external progress reports	Accountability, understanding, promotion and support	Annual	Format based on indicator tracking table and quarterly project reports	Review and feedback on report
Etc.					

Annex 3: List of ICT4RAg Projects 2016 – 2020

No.	Strategic Objective	Key Projects & Programs	Deliverables	Lead Agency
	Development of a common user interface and a repository for farmer and farm information	**Farmer Management Support System** • Farmers registration project (with land registration, link farmers to the credit , insurance and agro-input acquisition) • ALIS – Agricultural Land Information System • NozaUbuhinzi n' Ubworozi content mgmt. system • Early warning systems	• Integrated system to support farmers with farm management information: • Automated production management and intelligent distribution system • Improving effectiveness of government support to farmers • Promoting farmer entrepreneurship • Informed decision making and policy development • Automated information collection and storage • Communication between research institutions, end-users and manufacturers • (Open) standards for achieving interoperability • Web-based approaches for farm management and decision support • Easy-to-use interfaces	MINAGRI
		Agro-processing management system • Meat processing management system • Crop processing management system	Integrated system that automates agro product processing processes	MINICOM
		Agro-smart traceability • cattle management system • Animal husbandry database (e.g.; vaccination records, cattle registry, breeding, e-fishing,)	• Tracking, recording and accountability of agricultural products. • Automated Quality Control • Traceability: inspection principles • Sensors for quality- and contamination control in plant and livestock production • Control of each individual product instead of sample-based QC • Interoperability of products throughout the entire food chain	MINAGRI
		Agriculture Growth Management System • Digital orthophoto for digital map Precision Farming through Satellite Technologies – Use of GIS • Using Landsat to Assess Irrigation Systems – Irrigation scheme • Agri-Simulation models • Green house technologies • Remote sensing for precision agriculture: Using Unmanned Air Vehicle (UAV) to monitor crops	• Growth management of agricultural products using computer technologies and sensor network technology • Biosensors: better sensitivity and specificity • Improved decision support • Management of GHG emissions • Disease-risk assessment and modelling • Feeding systems • Compatibility between products from different vendors • Scouting crops, analyzing plant health, treatment of crops • Identification of pests, disease and weeds • Collection of tissue tests for fertility & disease issues • Collection of soil samples for soil, fertility, pH & pest issues • Digging plants, inspecting root structure for signs of compaction, disease, pests • Counting plants & determining population / spacing issues	MINAGRI

	Increase the number of skilled and knowledgeable farmers	**Esoko+**	• Provide relevant agricultural market price information and cross border trade information.	MINAGRI
		Capacity Building through online farming schools modelled on massive online open courses (MOOCs)	• farmer training program to help young farmers learn what it takes to run a small modern farm operation from business planning to specialized advanced workshops in both livestock and agro-farming • Use of social forums to encourage youth to engage in agriculture. The forum is a place to ask questions, and create agriculture networks, a posts photos and inspirational stories of farmers to empower youth their communities • Demo farms operated by young farmers	MINAGRI
	Spur job creation among youth in agricultural sector	• Foster local and appropriate system/tools /thing (IOT)/use different technologies (e.g.; drones) and innovation spaces (e.g.; KLab, FabLab, etc.) • Create and promote localized appropriate ICT/technology solutions(e.g.; micro sensor, apps, and other home grown systems) through innovation centers(e.g.; FabLab, KLab, PDU, etc.) • Digitize and automate FFS and Twigire Muhinzi Model • Variable-Rate Application	• Provide a conducive environment to the new emerging and evolving innovations / technologies. • Proximal sensing technologies for plant-nutrient status • Detection of biotic and abiotic stresses: weeds, fungal diseases, water stress • Mapping of soil characteristics (new and improved sensors) • Remote sensing • information management, farm management and (weather-based) decision support	MINAGRI
		Agriculture info. Service Center • local telecenters • Using radio, video, and other appropriate medium to reach Rural Farmers • Making Information Accessible through Mobile Phones and Internet • Strengthening Call Center (CRM)	The partnership between MINAGRI and different decentralized centers such as CCI, BDF, Telecenters, Knowledge Hub will be strengthened so that all the services to be provided to the farmers will be accessible in those centers with affordable cost.	MINAGRI/ MYICT
			Provide agricultural and livestock products information, cultivation techniques, policy,: By call or SMS, farmers get various agricultural information from informers in an Agriculture Info. Service Center	MINAGRI
	Increase access to agricultural information, knowledge and market	ICT4RAg Knowledge Management System	Knowledge management system will be developed to strengthen ICT4RAg steering committee on planning, coordination and Monitoring and Evaluation.	MINAGRI
	Support access to and the uptake of agricultural finance	Create credit models which allow banks to vet farmers for loans and develop appropriate products	• integrate databases of data from population distribution, predominant crop types and soil types, to previous weather patterns and estimates of supply • use of ICTs to reduce cost of access to small holder farmers	MINAGRI/ MINICOM