REIMAGINING PUBLIC EXTENSION:

POLICY, PLURALISM, AND NEW ROLES

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ABSTRACT

As the world look to agriculture for urgent solutions in food insecurity and climate change, the role of extension and advisory services in assisting farmers with advice and information, brokering and facilitating innovations and networks is needed now more than ever. This paper explores the current state of agricultural extension and advisory services using a structural and functional analysis of the Agricultural Innovation Systems (AIS) in Senegal and Kenya through a comparison of policies and case studies on donor and private sector involvement. The paper found that while both countries have benefitted from increased investment in agriculture, weaknesses remain in research-extension linkages and coordination mechanism for pluralistic extension. It recommends donor projects to emphasize advancing the capacity of actors in the AIS to take charge of the function themselves, and to encourage the private sector in playing a complementary role to the public sector, especially in transferring excludable agrarian information.

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BIOGRAPHICAL SKETCH

Sumire is a development practitioner, an actor, and a director. Growing up in many different parts of the globe, she had her heart set on a career in international development since her teenage years. She holds a Bachelor of Arts from Middlebury College, VT, where she studied as a Theatre and Political Science Joint Major and French and African Studies Double Minor.

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LIST OF ABBREVIATIONS

AIS	Agricultural Innovation System
ANACIM	National Agency of Civil Aviation and Meteorology (Senegal)
ANCAR	Agricultural and Rural Advisory Services (Senegal)
ANIDA	National Agency for Agricultural Insertion and Development (Senegal)
ANR	National Rice Association (Senegal)
ASPRODEB	Senegalese Association for the Promotion of Bottom-Up Development
CINSERE	Climate Information Services for Increased Resilience and Productivity in Senegal
CIRIZ	Interprofessional Committee of the Senegalese Rice Sector
CNAAS	National Agriculture Insurance Company of Senegal
CNCAS	Senegal National Agricultural Bank
CNCR	National Council of Rural Cooperation (Senegal)
DMER	Directorate of Rural Equipment Modernization (Senegal)
DRDR	Regional Directorate of Rural Development (Senegal)
EU	European Union
FFS	Farmer Field School
FSR	Farming Systems Research
GAP	Good Agricultural Practices

GDP	Gross Domestic Product
GPS	Global Positioning System
GIE	Economic Interest Groups
ICT	information and communication technologies
IFC	International Finance Corporation
ISRA	Senegal Institute of Agricultural Research
ITS	irrigation technology suppliers
JASSCOM	Joint Agriculture Sector Steering Committee (Kenya)
JICA	Japan International Cooperation Agency
KALRO	Kenya Agricultural and Livestock Research Organization
KARI	Kenya Agricultural Research Institute
KASEP	Kenya Agricultural Sector Extension Policy
KLPA	Kenya Livestock Producers Association
KHE	Kenya Horticultural Exporters Ltd.
LBA	Agricultural Bank
MAER	Ministry of Agriculture and Rural Equipment (Senegal)
MALFC	Ministry of Agriculture, Livestock, Fisheries and Co-operatives (Kenya)
MRL	maximum residue limit
NASEP	National Agricultural Sector Extension Policy (Kenya)
OECD DAC	Organization for Economic Co-operation and Development – Development Assistance Committee

OLAC	Office of Lakes and Watercourses
PAPRIZ2	Project for Improvement of Irrigated Rice Productivity in the Senegal River Valley
PRACAS	Program for the Acceleration of Agricultural Growth in Senegal
PSE	Emerging Senegal Plan
SAED	National Society for the Development and Exploitation of the Land of the Senegal River Delta
SME	small and medium-sized enterprises
SODAGRI	Agricultural and Industrial Development Agency of Senegal
SODEFITEX	National Fiber and Textile Development Agency (Senegal)
SRV	Senegal River Valley
SWAG	Sector Working (Agriculture) Group
TOT	Transfer of Technology
ToT	Training of Trainers
UK	United Kingdom
USAID	United States Agency for International Development
USSD	Unstructured Supplementary Service Data
VAT	value-added tax
WRS	warehouse receipt system

INTRODUCTION

Agriculture supports the livelihoods of more than a billion smallholder farmers in developing countries. A crucial sector for inclusive growth and climate mitigation/adaptation, agriculture is one of the most important sectors in global development. To address the mounting challenges of low productivity, food insecurity, malnutrition, environmental degradation, and resilience in the face of climate change, the role of extension and advisory services is crucial in assisting farmers with advice and information, brokering and facilitating innovations and networks.

In the past, public agricultural extension had significant effects on the adoption of technology such as modern varieties and intensive cultivation techniques during the Green Revolution in Asia. However, the public extension system was weakened by the structural adjustment policies of the 1980s and 1990s, and its finance remains insufficient and donor-driven, with little consideration for sustainability. The number and the capacity of extension officers are insufficient, many struggling with lack of transport and low salary. Linkages among research, extension services, and farmers are weak, preventing farmer feedback to inform the relevance of research. (Davis 2020)

A wide range of approaches to agricultural knowledge generation, extension and advisory services has emerged over the past 40 years. The Transfer of Technology (TOT) approach (Jarrett 1985), which many of the extension and advisory services continue to be based on, focuses on the linear diffusion of technology from formal agricultural research and development institutions (typically within government

Ministries of Agriculture) to farmers. Farming Systems Research (FSR) emerged in response to critiques that products of conventional research were ill-suited to the needs of small, limited resource farmers in complex, diverse, risk-prone environments (Chambers and Jiggins 1987). FSR developed as a multidisciplinary team-based research method that emphasizes on-farm experimentation and comprehensive understanding of the farming systems in environments quite distinct from the research stations of government and universities. The Farmer First approach (Chambers et al. 1989) emphasized the need for equitable partnerships between farmers and researchers in the design of technology, blending in rural people's knowledge with scientific knowledge. The Beyond Farmer-First approach (Scoones and Thompson 1994) advocated for a non-populist perspective that acknowledges the diversity of rural people's knowledge systems and the complexity of divergent interests that requires conflict resolution. Other well-known approach includes the Training and Visit system, a centralized, highly structured, and largely TOT-based system that featured regular farm visits and continuous training of agents and subject matter specialists. Farmer Field Schools (FFS), still very much in evidence today, emerged in the 1980s as a participatory, group-based approach which is based on experiential learning, with intensive training offered over a long period of time, often on a demonstration farm. The past two decades have seen the emergence of more (and more diverse) actors in agricultural knowledge generation, dissemination, and innovation, along with greater attention to the challenges and opportunities that accompany greater pluralism. There is greater recognition that practical, actionable innovations often require deeper involvement of actors beyond the traditional research and public extension

organizations that have long dominated the agricultural knowledge and information system. More contemporary concepts of agricultural development center around the need for high-functioning Agricultural Innovation Systems (AIS), which are defined as "network(s) of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into economic use, together with the institutions and policies that affect the way different agents interact, share, access, exchange and use knowledge" (Hall et al. 2006).

This paper explores the current state of agricultural extension and advisory services with an eye toward pluralism, platforms and processes that support innovation, and the role of policy in creating an effective enabling environment. Senegal and Kenya are examined for this comparative case study. The first chapter compares the structure of the AIS in the two countries through a policy lens, dissecting the governance structure and policy environment, and organizational and management capacities. The second chapter considers the function of AIS, using two donor projects from Senegal to analyze the ways in which donor interventions are supporting the AIS, and the remaining gap that needs to be filled. Finally, the third chapter explores the role of the private sector in the AIS, using two case studies from Kenya.

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CHAPTER 1: POLICY COMPARISON

I. Introduction

Agricultural extension in developing countries have moved away from a technology transfer model led primarily by the public sector, to an increasingly pluralistic system. There are several causes of this change. Growth in agricultural productivity has caused structural change in the agriculture sector: small commercial farms now coexist with smaller semi-subsistent farms in developing countries. Commercialization has increased the demand for client-specific information, which are best provided by private firms. New types of agricultural technologies, such as improved seeds, fertilizers and machinery have also expanded the proportion of extension information embedded in inputs by the private sector. Decrease in government funding for agricultural extension further pushed extension services to pluralism. The emerging information and communication technologies (ICT) have provided a low-cost and timely method to spread agricultural information. The decentralization trend in many governments has localized agricultural extension services, with the intention to make them more demand driven and accountable. This changing landscape is reflected in the policy realm. Pluralism is embraced and priorities are refocused to make agricultural extension more effective and efficient.

This chapter explores the question: “how can the public sector design agriculture and rural development policy that incentivizes and supports effective agricultural innovation systems that address smallholder farmer needs for advisory services,

appropriate technology, market access and high impact membership organizations?" This chapter analyzes the structure of the agricultural innovation system of Senegal and Kenya from two perspectives: 1) Governance structure and policy environment, and 2) Organizational and management capacities. Then, the extension policies from the two countries will be contrasted based on SWOT analysis.

II. Senegal

(1) Governance Structure and Policy Environment

Policy Environment

The agriculture policy in Senegal can be characterized as liberal interventionism; government interventions aim at increasing productivity, food security and self-sufficiency, with a focus on strategic value chains: rice, onions, groundnuts, and off-season fruits and vegetables. The Program for the Acceleration of Agricultural Growth in Senegal (PRACAS 2013-2017) is a program that aimed to operationalize the Emerging Senegal Plan (PSE, 2013-2035), the national development plan. The program contained overambitious production goals for priority value chains, which weren't all attained at the end of the target period. Under PRACAS, subsidies for fertilizer and improved seeds were established, which amounted to 70% of improved seed and 55% of fertilizer in the market in 2015.

Relative to other African countries, Senegal is unique in a sense that the producer organizations play a strong role. Economic interest groups (GIE), formed in 1984 (Law 84-07), have a legal status to access credit and conduct for-profit activities, and are popular in sub-sectors such as livestock, horticulture, fishing and forestry.

Many of these GIEs group together to form national networks as unions and federations. The National Council of Rural Cooperation (CNCR), founded in 1993, is composed of 9 federations, and plays an important role in lobbying for smallholder interests with the state. A government policy directive titled Institutional Development of the Agricultural Sector (1999), strengthened the capacity of producer organizations to play a leading role in development activities (Mboup and Anouilh, 2008).

Senegal's commitment to agricultural development is reflected by its high investment in agricultural research. Agricultural research expenditures increased by over 50% from 2012 to 2014 (Franzel et al. 2018). Public expenditures on food and agriculture increased by 67 % between 2010 and 2015 (Franzel et al. 2018). Spending on agricultural research in Senegal has increased significantly in recent years, mostly due to increase in the World Bank funding. Spending in 2014 was at 1.15% of agricultural Gross Domestic Product (GDP), which is above the minimum target set by the African Union, and high relative to other West African countries. However, staffing is low relative to other African countries of its size. To facilitate an increase in staffing, the government doubled researchers' salaries in 2012 and approved recruitment and training of 10 researchers per year over the next 10 years.

Relevant Actors

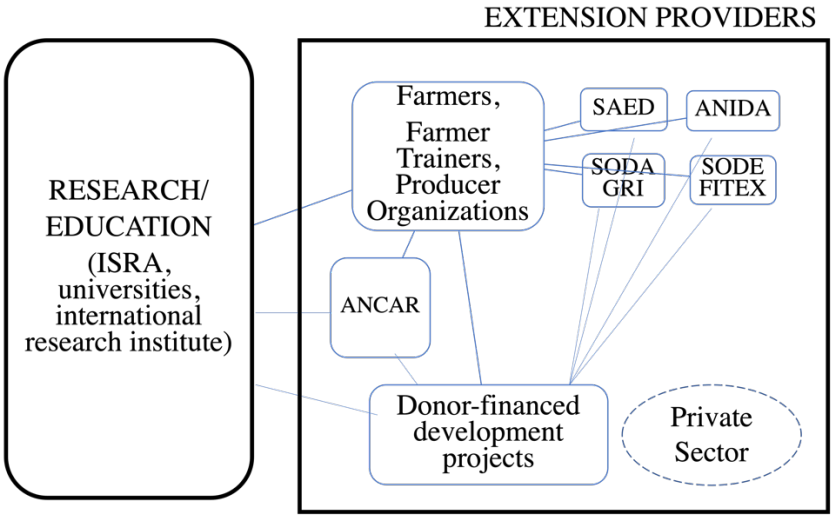


Figure 1-1: Agricultural Innovation System in Senegal
(Adapted from Franzel et al. 2018)

The main actors of the agricultural innovation system in Senegal can be divided into two categories: research and educational institutions and extension providers. A diverse set of public, private and civil society organizations can be found in both categories. Research and educational institutions include the Senegal Institute of Agricultural Research (ISRA) which has an autonomous administration under the Ministry of Agriculture and Rural Equipment (MAER), with the mission to create scientific knowledge and develop technological innovations, tools, and approaches to improve the agriculture sector. Agricultural science is taught in educational institutions such as Gaston Berger University (St. Louis), University of Thies (Thies) and Assane Seck University (Ziguinchor). The Community Service Law (Law no. 18 of 2014) has established the legal authorization for universities to establish outreach programs to work with local communities. In partnership with international donors, these universities have started working in development projects to assist farmers,

including provision of advisory services. In the private sector, some companies conduct agricultural research. For example, TROPICASEM, a private seed company that operates in West Africa, conducts research on improved varieties for vegetables to produce and market the seeds.

Extension providers include National Agency for Agricultural and Rural Advisory Services (ANCAR), National Agency for Agricultural Insertion and Development (ANIDA), National Society for the Development and Exploitation of the land of the Senegal River Delta (SAED), Agricultural and Industrial Development Agency of Senegal (SODAGRI), and National Fiber and Textile Development Agency (SODEFITEX). ANCAR is a governmental organization that conducts extension and advisory services in all regions of Senegal. The Agro-Sylvo-Pastoral Law of Senegal (LOASP, 2004) mandated ANCAR not only as a provider of extension and advisory services, but also as a coordinator of these services. ANCAR is responsible for improving advisory service delivery, harmonizing advisory methods, and facilitating a network of public and private advisory services. ANCAR is a parastatal led by the national government (51% of capital) with representation from producer organizations (28%), private sector (14%), and the local government (7%). At the time of its creation, the role of the state was expected to decrease with time, and the producer organizations were expected to be the major capital provider. However, no private entities have had the means to contribute, and therefore, currently, the national government pays most of ANCAR's costs. The advisory services are offered through a financial contract between ANCAR and the producer organizations. However, out of 3,800 contracts ANCAR had signed with producer organizations in 2009, most

organizations lacked funds to contribute financially. For farmers who are not organized in producer organizations, ANCAR uses its own funds to provide extension and advisory services.

ANIDA is a governmental organization with the objective to create large, modern farms in "community agricultural domains," primarily to serve as employment opportunities for rural youth and to promote agricultural development. In 2018, 12 domains were in operation, and included over 100 farms.

SAED is a governmental organization funded by MAER but given autonomous administration. The main concern of SAED is to develop irrigation infrastructure and to promote irrigated rice in the Senegal and the Falémé River Valleys. However, SAED is also active in the domain of input supply, processing, marketing, the development of producer organizations, promoting youth and women entrepreneurship, and the cultivation of vegetables, such as onions and tomatoes.

Similarly, SODAGRI is a governmental organization funded by MAER but given autonomous administration. It promotes irrigated agriculture, mainly rice, through construction of irrigation systems along the Anambe River.

SODEFITEX is a public-private partnership with a French private company, Geocoton, owning a minority share. It was established to promote cotton development in southeastern Senegal. Farmers can access inputs and credit and market their cotton through SODEFITEX. Since its establishment, the organization has gradually evolved to broadly serve farmers in other sub-sectors such as livestock, cereals and vegetable production, farm management services, and literacy campaigns.

Although limited in scale, some private sector actors also provide extension and advisory services, such as produce traders, processors, input suppliers and service providers. There are cases in which private sector actors provide credit, agricultural information, and agricultural insurance to farmers.

Coordination Mechanism

Research-extension-farmer linkages are weak, as "ISRA and the extension agencies compete for scarce resources rather than [collaborate] as part of a broader agricultural innovation system." (Domgho et al., 2017) Research-extension-farmer coordination is under the mandate of ANCAR in each region, through the Research-Development Committees where researchers, extension services, producer organizations and other stakeholders are expected to meet periodically. However, many committees are not operating due to financial constraints.

Franzel et al. (2018) reports three cases where platforms of actors were formed to promote exchanges of experience and extension coordination, often with backing from donors. The National Science Policy Dialogue Platform for Adaptation to Climate Change (CCASA), supported by Research Program on Climate Change, Agriculture and Food Security (CCAFS) of the Consultative Group on International Agricultural Research (CGIAR), has initiated 11 local platforms at the district or commune level across Senegal. As a second example, ISRA initiated an innovation platform on forestry and agroforestry, as part of a project financed by The West and Central African Council for Agricultural Research and Development (CORAF) and CCAFS/ International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in the

region of Kaffrine. A third example is that of the Task Force TaFaé, which brings together organizations promoting agroecology in Senegal, such as The French Agricultural Research Centre for International Development (CIRAD), Food and Agriculture Organization of the United Nations (FAO), the Mixed Laboratory for Ecological Intensification, Cheikh Anta Diop University, Institute of Research for Development (IRD), and other NGOs and farmer organizations.

(2) Organizational and Management Capacities

Human Resources

With a total of 156 extension staff at the point of 2018, consisting of 144 field extension staff and 12 managers (one per region), ANCAR has a staff stationed in each of Senegal's 45 districts and 190 counties. However, there were a 24 % vacancy rate in 2017, a chronic problem due to lack of funds to pay the salaries of new staff members. Regional directorates include a team of technical specialists to support the field teams (about three per region). ANCAR field teams are based at the district level, and are composed of three to four extension staff, supported by two to three subject matter specialists of different disciplines. SAED employs 85 field extension staff equipped with motorbikes and 12 supervisors equipped with four-wheel drive vehicles. Extension activities include participatory diagnosis, needs assessment, implementation and monitoring and evaluation. ANIDA employs 70 extension agents, supervised by 12 extension managers, and SODEFITEX employs 83 extension agents and 26 extension managers. SODAGRI employs 20 extension agents and 10 extension

specialists. In addition, Senegal has a strong history of farmer trainers who total to about 9,100 (Franzel et al. 2018).

Among the public sector and the NGO extension and advisory service providers, most managerial staff and extension specialists hold M.Sc. or B.Sc. degrees in agriculture, and field agents generally hold diplomas from agricultural training institutes. While most staff have strong knowledge in agriculture, only a few have been trained in the functional skills of extension, such as communication, network brokering, innovation process management and institution building, which are skills increasingly required in a pluralistic extension system. This lack of training is partly because these courses are not offered in universities and training institutes, and also because of a general misunderstanding that personnel knowledgeable about agriculture should naturally be able to train farmers (Franzel et al. 2018). For example, there are three universities that offer degrees in agriculture: Gaston Berger University, University of Thies, and Assane Seck University, however, no university offers a degree in agricultural extension. Nevertheless, the demand for training in functional skills of extension is high; Ndiaye (2015) found that 80% of extension agents in Senegal felt that communication is a necessary skill for development, and that 84% felt that development facilitators need training in communication. In order to increase the effectiveness of extension, training of extension agents should include these functional skills.

Performance, Accountability, Monitoring and Evaluation

Performance management systems are notably absent in most of the public sector extension system. For example, SAED has no such systems, and there are limited incentives for the extension agents to perform well on the job (Franzel et al. 2018). Institutions that do have a performance evaluation measures in place tend to focus on distribution of inputs rather than on the uptake of technologies or other outcomes due to its ease of measurement. In addition, paths to career development or opportunities for further education are limited. An exception to this is when the extension agent is working on projects financed by donors, as there are some opportunities to get selected to participate in short-term courses.

Use of Mass Media and Information, Communication and Technology (ICT)

Relative to other countries, ICT and mass media approaches are not widely used in Senegal. Apart from an agricultural radio program named Disso on the national broadcasting system that covers agricultural news, no regular programs target farmers to provide information about agricultural technologies and other innovations. However, some organizations do use radio to publicize their activities and promote practices. In addition, climate information from the National Agency of Aviation and Meteorology (ANACIM) is broadcasted to farmers through 82 rural community radio stations, as well as through SMS messages, reaching 3.9 million rural people.

According to a survey conducted in the Senegal River Valley and the Niayes zone in 2013 by Ndiaye (2015), most extension agents had access to ICTs (72% owned cell phones, 64% had email accounts, 48% owned laptop computers and 40%

had access to desktop computers). However, they were using these mostly for personal purposes and not as a tool to reach farmers. ICT availability has increased greatly since 2013, but most extension agents use limited ICT in their field work.

One example of use of ICT for accessing agricultural information is a private service named Mlouma, a mobile and web-based platform that provides market price information in 10 regions and is used by 130,000 people (Franzel et al. 2018). In partnership with the Orange mobile network, it utilizes the Unstructured Supplementary Service Data (USSD)[1] service to allow buyers and sellers to access price information using basic feature phones. 15 Mlouma agents collect price and market information on 50 different crops and products. The proportion of the cost of operation is paid by the users to Orange (priced per information, or by weekly and monthly subscriptions). Mlouma also gain funding from NGOs to train their target farmers on how to use the service.

III. Kenya

(1) Governance structure and policy environment

Policy Environment

In an effort towards devolution, the Constitution of Kenya (2010) created government bodies at the county level. To reflect this change, Kenya Agricultural Sector Extension Policy (KASEP 2022) (Draft) would replace the National

[1] Unstructured Supplementary Service Data (USSD) is a function in a mobile phone which creates a real-time connection to send text messages. It does not require an Internet connection and can be used on basic phones. It allows users to interact directly from their mobile phones by making selections from various menus. The feature is often used for mobile services, prepaid callback service, location-based content services, and menu-based information services.

Agricultural Sector Extension Policy (NASEP 2012) and clarify the role of two levels of government entities. The national government develops the national extension policy, standards and guidelines for extension and advisory services, and provides capacity building and technical assistance to the counties. The county governments provide extension and advisory services in crops, livestock, fisheries, and cooperative development subsectors. Decentralized extension system is generally expected to reflect farmer demand better by making it accountable to locally elected officials. It also facilitates the production and delivery of site-specific extension information. However, potential dangers of devolution include loss of economies of scale, perception of extension agents as being politically motivated, inadequate local funding, difficulty in staff retention, and corruption. In fact, there were reports of administrative services stagnating due to competition over budget and leadership between the county and the central governments, especially during the transition period between 2013 and 2017 (JICA 2020). In the county governments, the strong authority of County Executive Committee Member and the Chief Officer over budget allocation has reduced the involvement of technocrats in decision-making regarding agricultural administration, making the planning process more top-down. Moreover, the county governments tended to prioritize interventions that are visible to voters, such as construction of small-scale packing houses, provision of a green house, free distribution of grafted saplings, etc, which often lacked technical follow-up. Nevertheless, as KASEP (2022) is still at a drafting stage, the impact of clarifying the roles of actors under the decentralized extension system in Kenya cannot be determined yet.

Like NASEP 2012, pluralistic extension service is at the heart of draft KASEP 2022. The extension system in Kenya involves the public sector represented by the government and a range of entities in the private sector, working collaboratively to address both smallholder farmers and commercial farmers. The draft KASEP 2022 addresses the issues of harmonizing extension approaches and methods to effectively manage pluralistic extension service and to develop the private sector operated extension services to complement public extension services. It also discusses the need for privatizing extension services without compromising public interest. While these policies guide improvements in the delivery of extension services and create an enabling environment for agricultural innovation system to function effectively, there are concerns over the effectiveness of the pluralistic agricultural extension systems, especially in the ability for limited resource farmers to access paid extension services (Oliveira 2018). The private extension services are not a substitute for public extension and the public sector needs to continue funding extension in ways that do not duplicate services already being provided by other providers. Since 2013, the county governments have increased funding to the agriculture sector. However, financial support for the provision of extension services remains small, hindering extension provision across the country. Therefore, adequate resource allocation to public extension services and demarcation between public and private extension remain a potential challenge in the implementation of Draft KASEP 2022.

Table 1-1: Summary of Policies Relevant to Agricultural Extension in Kenya

Scope	Name (year)	Description
Overarching policy plans	Big4Agenda (2017)	Action plan to foster economic development through 4 pillars: i) food security and nutrition, ii) affordable universal health care, iii) affordable housing, and iv) enhancing manufacturing. Food security and nutrition pillar targets a 700,000 acre (283,280 ha) increase in the large-scale production of staple crops. Priority to enhance the productivity of smallholders through improved access and reduced prices of locally accessed agri-input, as well as waiving import duties on post-harvest storage equipment.
	Kenya Vision 2030 (2008)	National development plan. Economic and Macro pillar includes improving agricultural development by increasing the area under irrigation, especially in the Arid and Semi-Arid (ASAL) areas of Turkana and the Tana Delta.
Agricultural strategies	Agricultural sector transformation and growth strategy 2019-2029 (2019)	A ten-year sectoral plan that aims to increase food security. One of its overall goals is to increase agricultural production from small-scale farmers as a mean to generate an income and improve livelihoods. It also included a goal to attain the ratio of one extension personnel against 600 farmers by the year 2029, calling for greater coordination among extension service providers, and the utilization of information and communication technology. The strategy has specific targets to be achieved within the first five years relating to extension which include building technical and management skills in the field for 200 national and county government staff, 1,000 farmer-facing small and medium-sized enterprises (SMEs), and 3,000 extension agents among others. In addition, the strategy integrates the use of the e-voucher system for input provision, extension services to inform farmers of soil needs among other strategies aimed at promoting extension services across the country.
	Kenya climate smart agriculture strategy 2017-2026 (2017)	Plans for climate mitigation and adaptation in the agriculture sector. The objective is to improve the resilience of agricultural systems while keeping greenhouse emissions low, ensuring enhanced agricultural production.
	Agriculture Policy 2021	Objective: to promote appropriate, cost effective and affordable extension services for different agro-ecological zones through strengthening research-extension-farmer liaisons, regulation and quality assurance, enhancing private sector engagement and providing adequate resources towards the delivery of extension services. Outlines suitable guidelines to national and country governments to addresses challenges in the agriculture sector. It specifies the role of governments to ensure household and national food and nutrition security, food safety, increasing agricultural productivity through use of farm inputs, facilitating access to markets, reducing postharvest losses, value addition and product development. The policy includes guidelines relating to the promotion of demand-driven research and timely dissemination of research findings.

Extension Policies	National Agricultural Sector Extension Policy (2012)	Outlines the modalities for effective management and organization of agricultural extension services in a pluralistic system where both public and private service providers are active participants. The policy identifies: i) the need to progressively move towards privatization and commercialization of extension service delivery, articulating the importance of clientele participation and demand-driven extension system. ii) efficient, effective coordination and regulation of extension servces iii) sustainability of extension service delivery through three financing models: publicly funded, cost sharing and private sector funding. NASEP is operationalized by The Agriculture Sector Development Support Programme (ASDSP).
	Kenya Agricultural Sector Extension Policy (2022) (Draft)	New extension policy (Draft) that would replace NASEP (2012). It clarifies the roles of the national government and the couny government, as the Constituion of Kenya (2010) dessignated specific functions to each: the national government retains the executive function of policy decision making, while the counties implement the policies generated by the national government. National government: - development of national extension policy, standards and guidelines for extension and advisory services - capacity building and technical assistance to the counties County government: - provision of extension and advisory services in crops, livestock, fisheries, and cooperative development subsectors It addresses the issues: i) institutional weaknesses in capacity building, technology development and dissemination ii) harmonizing extension approaches and methods. iii) managing pluralistic extension service for effective service delivery iv) commercializing and privatizing public extension services without compromising public interest v) weaknesses in research-extension-clientele linkages, packaging and disseminating technologies vi) developing private sector operated extension services to complement public extension services vii) creating functioning institutional frameworks to coordinate and provide linkages among stakeholders and mainstreaming cross-cutting issues in extension messages. It also provides a point of reference for stakeholders on standards, ethics and approaches to strengthen coordination, partnership, and collaboration. It aims to: i) enhance the capacity for extension through human resource management and development, infrastructure for extension and funding ii) establish an integrated knowledge management system, iii) improve research-extension-clientele linkages iv) improve coordination and enhancing partnerships and collaboration

		v) creation of a legal and institutional framework that supports extension

(Adapted from Hornum 2020 and KASEP 2022)

Relevant Actors

In Kenya, agricultural extension services are provided by three main groups: the public sector, the private for-profit sector, and the private non-profit sector. The public sector includes the Ministry of Agriculture, Livestock, Fisheries and Co-operatives (MALFC) through the Directorate of Extension, Research and Technical Training. Public research and education institutions include Kenya Agricultural Research Institute (KARI), Kenyatta University, and International Livestock Research Institute, to name a few. The public sector is mainly responsible for setting extension guidelines and generating relevant knowledge through research.

The private for-profit sector includes commercial production, processing, and marketing firms such as input manufacturers and distributors, and farmer or farmer group operated enterprises. While most extension services in the past focused on production, the private sector extension services are now providing value addition support and linkages with output markets (Oliveira 2018). Private companies also co-finance agricultural shows and invest in extension as part of their marketing strategy. Local membership-based entities such as associations and cooperatives also facilitate the marketing of agricultural output, mutual help assistance and acquisition of agricultural credit. Community labor-sharing groups provide labor to farmers during critical periods of the cropping season when help is needed to accomplish heavy farm tasks such as ploughing, planting, and harvesting. Some development organizations

partner with these local institutions to promote and share new farming and conservation practices through farmer-to-farmer extension. An example of farmer organizations that provide agricultural information and services include the Kenya National Federation of Agricultural Producers (KNFAP), the largest farmers union in Kenya whose mission is to "empower its members to make informed choices for improved sustainable livelihoods".

The private nonprofit sector consists of local and international NGOs, community boards and associations, and bilateral and multilateral aid projects. Most of them promote commercialization of small-scale agriculture, and provide training on calendarization[2] and marketing. The majority of NGOs rely on the government research institutions for technology.

Coordination Mechanism

Joint Agriculture Sector Steering Committee (JASSCOM) is the coordination mechanism between the two levels of governments: national and county. The Research, Extension and Capacity Building Sector Working (Agriculture) Group (SWAG) is one of the four SWAGs established by JASSCOM to facilitate capacity building of national and county bodies to enhance intergovernmental technical consultation. At the county level, County Sector Steering Committees (CASSCOMs) are being set up, but most are weak and there is limited coordination (Draft KASEP 2022). Linkages between research, extension, and farmers remain weak, due to

[2] Risk management strategy for price depression of product by avoiding sales during high season.

inadequate exchange of agricultural research information and feedback, and the shortcomings of institutional frameworks.

(2) Organizational and management capacities

Human Resources

Staffing levels at public extension services are low. In 2011, there were 5,470 staff members in government or ministry-based extension organization (Oliveira 2018). While NASEP (2012) calls for extension agent to farmer ratio of 1:400, the national average is around 1:1000 (Hornum and Bolwig, 2021). In addition, the average age of public extension workers is 50 years old (Draft KASEP 2022). As significant proportion of staff nears retirement age, there are rising concerns about the capacity development of a new generation of extension workers, especially because the enrollment of youth in agriculture related courses has decreased over the years.

Table 1-2: Human Resources in the Public Extension Service in Kenya

Major Categories of Extension Staff	Secondary School diploma		2-3 yr. Ag diploma		B.Sc. degree		M.Sc./Ing. Agr. degree		Ph.D. degree	
Gender	F	M	F	M	F	M	F	M	F	M
Senior Management Staff					246	553	48	59		4
Subject Matter Specialists (SMS)					1023	2063				
Field Level Extension Staff			472	992						
Information, Communications & Technology (ICT) Support Staff				10						
In-Service Training Staff										
Total Extension Staff: 5470			472	1002	1269	2616	48	59		4

(Adapted from IFPRI/FAO/IICA Worldwide Extension Study, 2011; Oliveira 2018)

Extension agents have low levels of specialized skills and narrow scope of knowledge for extension delivery (Draft KASEP 2022). In terms of education, in 2011, about 73% of the staff members held a Bachelor's degree or higher. All field level extension staff had a 2 to 3-year agricultural diploma. Kenyatta University and Egerton University provide formal training in agriculture and related fields at the

degree and diploma level. The Directorate of Extension, Research Liaison and Technical Training of the Ministry of Agriculture oversees the planning and management of technical requirement and training needs of human resources related to public agricultural extension. The ministry has two colleges: Bukura Agricultural College for upgrading skills of serving officers from certificate to diploma level, and Embu Agricultural Staff Training College (EAST College) that focuses on short refresher courses for in-service agricultural professionals (Oliveira 2018). However, there is limited institutional capacity to train extension providers and researchers on emerging issues such as biotechnology, organic farming, and indigenous knowledge management. Moreover, much of the trainings emphasize technical knowledge, and lack instructions on functional skills such as communication, network brokering, innovation process management and institution building, which are skills increasingly required in a pluralistic extension system.

Performance, Accountability, Monitoring and Evaluation

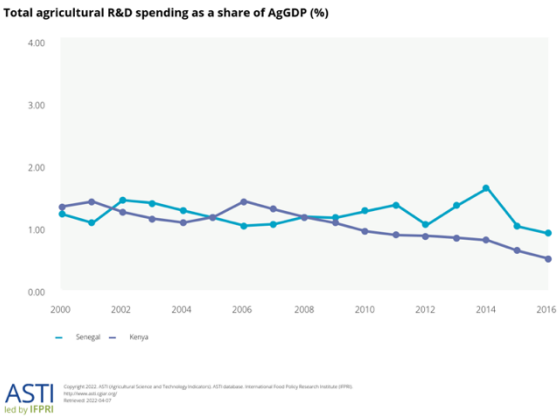
Standards and guidelines for agricultural extension were developed in 2017 by the Ministry of Agriculture (now MALFC) and the Ministry of Livestock and Fisheries (now MALFC) in consultation with the county governments and other stakeholders. This guideline aimed to maintain professionalism, harmonize, and create consistency in the extension service delivery targeting all agricultural sector stakeholders. However, due to lack of legal framework to enforce the standards, the level of quality envisaged in the guideline is yet to be achieved.

Usage of Mass Media and Information, Communication and Technology (ICT)

In Kenya, exhibitions and demonstrations are widely used while the use of lead farmers and e-extension is growing. Mass media methods include videos, television, radios, e-extension and SMSs. While mass media methods have a large outreach and audience, it has the downside of lacking practical aspects required for the adoption of technology by the target farmers. In addition, the operation and the access to media is expensive, and may not be interactive in nature.

Digital platforms have been set up for knowledge management for example in: the ministry website, county digital platforms, Big Data System at Kenya Agricultural and Livestock Research Organization (KALRO), Kenya Agricultural Observatory Platform (KAOP), Kenya Integrated Agricultural Marketing Information System (KIAMIS), Livestock Marketing Information System (LMIS), and Cooperative Management Information System (CMIS). In addition, there are mechanisms for dissemination of information through Disruptive Information System (DIS) innovations, which are supported by the private sector. However, despite investment in digitalization, the data management system is fragmented in the agriculture sector, as the institutional mechanisms for knowledge management is weak.

IV. Conclusion: Comparisons of Policy Environment between Senegal and Kenya



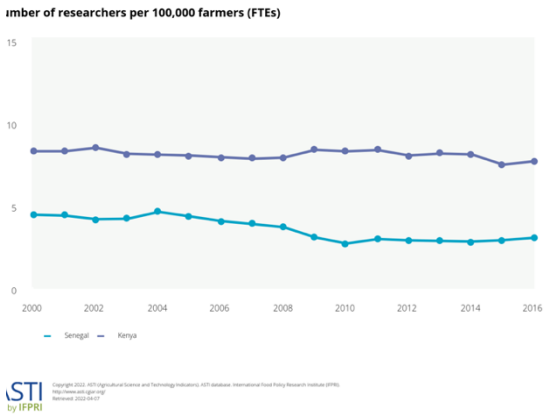


Figure 1-2 (Left): Total Agricultural Research and Spending as a share of GDP in Agriculture (%) in Kenya and Senegal

Figure 1-3 (Right): Number of Researchers per 100,000 farmers (FTEs) in Kenya and Senegal

Increased government and donor investment in the agriculture sector is a common strength to extension policy environment in Senegal and Kenya. As it can be seen in Graph 1 above, the total agricultural research and development spending as a share of GDP in the agriculture sector has been maintained, despite the significant growth in GDP in both countries. However, the two countries differ in points of strengths such as the presence of strong producer organizations in Senegal and the widespread usage of ICTs in Kenya. The two countries have similar weaknesses such as weak research-extension linkages and the lack of coordination among actors in extension and advisory services. They have different weakness regarding the low use of ICTs in Senegal and the ongoing decentralization in Kenya. See Table 1-3 below for more details.

Table 1-3: Comparison of Policy Environment in Senegal and Kenya

STRENGTHS

SENEGAL	KENYA
Recent increases in government and donor investment in the agricultural sector.	
Agricultural development prioritized in national policies.	Comprehensive national extension policy that recognizes the need for a pluralistic extension system (NASEP 2012) and analyzes the system in terms of Agricultural Innovation System (KASEP 2022.)
Presence of strong producer organizations and their federations at the national and regional levels.	Widespread usage of ICTs and comparatively higher foreign direct investment (FDI).
Community Service Law of 2014 authorizing universities to provide advisory services to community organizations.	Standards and guidelines for agricultural extension in place.
Programs of farmer-to-farmer extension in place in many organizations, supplementing the limited number of professional extension staff available.	Presence of extension and advisory services provided by the private sector.

WEAKNESSES

SENEGAL	KENYA
Low profile and status of agricultural extension relative to agricultural research.	
Weak research-extension linkage; little collaboration exists in identifying farmer needs, conducting research on solutions or evaluating results of intervention.	
Inadequate resource allocation to public extension services.	
Lack of coordination among actors conducting extension and advisory services.	
Lack of a feedback culture in extension and advisory services; researchers and extension agents have no systematic ways to collect, analyze and feedback information on the performance of recommended practices, such as the farmer adoption rate, farmer modifications, and constraints to adoption.	
Absence of research results on the performance of advisory methods.	
Lack of a comprehensive national extension policy.	-
Absence of performance management systems for public sector extension staff, few or no incentives to perform well, and lack opportunities for continuing education or career development.	Much of the trainings emphasize technical knowledge, and lack instructions on functional skills (e.g. communication, network brokering, innovation process management and institution building).
Little training in extension are offered to students in universities.	Limited institutional capacity to train extension providers and researchers on emerging issues (e.g. biotechnology, organic farming, and indigenous knowledge management).

Low use of ICTs in extension and advisory services.	Decentralization of extension system in progress; resource allocation at the county level remains inadequate, and the economies of scale has been reduced.

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CHAPTER 2: PROJECT COMPARISON

I. Introduction

While many large-scale donor projects intervene at several levels of the value chain and involve multiple stakeholders, their comprehensive impacts on the AIS are rarely examined, partially due to their focus on logic framework and the pre-set indicators of outcomes. This could be problematic because project evaluations fail to capture the full scope of the project impact. This chapter explores the ways in which donor interventions are supporting the AIS, and the remaining gap that needs to be filled. This chapter compares two projects from Senegal with similar intervention zone, using the functional analysis perspective of the AIS.

II. Methodology: Overview of Functional Analysis

Many assessments of AIS are conducted through structural analysis, which focuses on the actors, their interactions, and the networks within the system. On the other hand, functional analysis focuses on what is achieved in the system. The function of an innovation system is to "pursue innovation processes to develop, diffuse, and use innovations." (FAO 2022) Several functions have been identified as necessary for an effective innovation system, notably: (1) knowledge development and diffusion, (2) resource mobilization, (3) guidance of search, (4) market formation, (5) entrepreneurial activities and experimentation, and (6) creation of legitimacy. Mapping the functions and their interactions are expected to inform policy by

identifying functions that accelerate innovation as well as those that hinders innovation. An overview of each function is described below:

(1) Knowledge Development and Diffusion

This function describes the capacity of knowledge generation through research, interaction, and exchange. It refers to the breadth and depth of knowledge and its evolution over time, including how it is diffused and combined in the system.

(2) Resource Mobilization

This function involves the financial and human capital, and other resources necessary to implement the activities within an innovation system. Financial capital may include access to credit and diversification of businesses, human capital may include education in specific technological fields as well as entrepreneurship, and resources may include products, services, and network infrastructure.

(3) Guidance of Search

This function refers to the ability to create a vision for the innovation system, including the selection of various options for technologies, markets, applications, and business models. It can include the incentives or pressures for the actors to enter the AIS: for example, their beliefs in growth potentials such as rising product prices, regulations and policies, articulation of demand from leading customers, or crises in the current business.

(4) Market Formation

This function describes the development of markets for novel products or existing products produced in a different way and/or with new attributes. This includes size, type, and demand of the market, as well as what drives the formation of the market such as institutional stimuli and standards.

(5) Entrepreneurial Activities and Experimentation

This function refers to the processes of testing potential innovations and sorting the successful and promising from the failures and low potential ideas. The successes are advanced toward broader use through social learning approaches. Entrepreneurial activities are also a key component to a healthy AIS, as they would turn the potential of new knowledge, networks, and markets into concrete actions to generate new business opportunities.

(6) Creation of Legitimacy

This function describes the social and institutional acceptance that are necessary before resource mobilization. Legitimacy also influences expectations among managers and their strategy (and therefore the function "guidance of search"). Mapping the functional dynamics of creating legitimacy includes analyzing the strengths of legitimacy of the AIS, in particular its alignment with the current legislation and socio-economic values, how legitimacy influences demand, legislation, and business behavior, and what/who influences legitimacy.

The functionalist approach to innovation systems assume that the system as a whole cannot operate well if the sub-functions are lacking or not interacting harmoniously. Therefore, in this perspective, interventions should focus on improving individual functions and their interactions with each other to enhance the AIS. This chapter will analyze how the selected projects intervened and what impact it had in each function of the AIS.

III. Overview of Projects

(1) USAID: Naatal Mbay

Naatal Mbay was a $24 million (USD) project funded by the United States Agency for International Development (USAID) between 2015 and 2019, with the primary objective of achieving inclusive agricultural sector growth through scaling up and expanding successful value chain approaches[3]. Building on previous USAID interventions such as the Economic Growth Project (2009 -2015), the project aimed to scale up to reach 130,000 households. It targeted the value chains of irrigated and rain-fed rice, maize, and millet in the geographic areas of the Senegal River Valley (SRV) and the South Forest Zone (including the central peanut basin and Casamance). The interventions comprised of three technical components:

a) Promote the adoption of productivity-enhancing technologies by smallholder farmers.

[3] Scaling up refers to the process of increasing reach (larger number of targeted population).Value chain approaches refer to programs that focus on enhancing the production, processing, and marketing and the links between the actors that bring products to market.

b) Improve the quality and volume of smallholder farmer sourcing systems for post-harvest activities by:
    - developing the capacity of farmer organizations and private-sector firms
    - supporting financial service providers and IT firms to develop new transaction and investment funding methods, adapt insurance packages, and design data management systems that are inclusive for smallholder farmers.
c) Create an information exchange platform between local and national policy makers by performing an additional analysis based on the knowledge and systems generated by a) and b).

(2) JICA: The Project for Improvement of Irrigated Rice Productivity in the Senegal River Valley (PAPRIZ2)

PAPRIZ2 is a $7.9 million (USD)[4] project funded by the Japan International Cooperation Agency (JICA) between 2016 and 2021, with the primary objective of improving the production and the quality of rice produced in the SRV. Building on previous JICA interventions such as the Project on Improvement of Rice Productivity for Irrigation Schemes in the Valley of Senegal (PAPRIZ; 2009 -2014), the project aimed to scale up geographically within the Department of Dagana and Podor. The interventions were comprised of four technical components:

[4] Calculated at USD 1 = JPY 107.908 (November 30, 2021 OANDA kiosk rate), the end rate of the month the project period of PAPRIZ2 concluded.

a) Support the development and implementation of the Rice Sector Master Plan (2018-2027) in the SRV
b) Promote participatory maintenance of irrigation scheme and rational water management through organization strengthening of Unions and GIEs
c) Improve productivity and quality of rice paddy by:
    - Supporting SAED in providing training on rice cultivation technique
    - Improving paddy quality management technique and disseminating quality rice seed
    - Building the capacity of rice millers
d) Improve the availability and the quality of agricultural machinery service providers through business / technical training, credit access, and network strengthening.
e) Develop and promote double cropping system of rice.

Table 2-1: Overview of Projects

Project Title	**Naatal Mbay**	**The Project for Improvement of Irrigated Rice Productivity in the Senegal River Valley (PAPRIZ2)**
Donor	USAID	JICA
Zone of intervention	SRV & South Forest Zone (Central Peanut Basin and Casamance)	SRV (activities mainly focused in the departments of Dagana and Podor)
Financial Input	$ 24 million (USD)	$7.9 million (USD)
Project Period	2015-2019	2016-2021
Overall Goal	Inclusive agricultural sector growth	Improvement of production / marketed volume and quality of rice in SRV
Project Objective	-	Improvement of production and quality of rice produced in the target areas in the SRV

Project Outputs	Component I: Agricultural productivity improved - Element 1.1 Agricultural input and production systems strengthened, scaled up, and expanded. - Element 1.2 Post-Harvest Systems Strengthened Component 2: improved agricultural markets - Element 2.1 market access and linkages to smallholders improved - Element 2.2 private sector investments increased - Element 2.3 Expanded access to finance and improved use of financial tools	- Programs/projects based on the Rice Sector Development Strategy / Master Plan (2018-2027) in the SRV is implemented. - Irrigation schemes are properly operated and maintained in the target areas - Productivity and quality of paddy are improved in the target areas. - Availability and quality of services provided by agricultural service providers in the target areas are improved. - System for double cropping of rice is disseminated in the target areas.
Implementing partners	Partnered with a range of umbrella organizations that represent smallholder farmers, producer organizations, a national think tank, insurance providers, banks, equipment leasing companies, and IT providers. Strategic local partners included the ANACIM, PlaNet Guarantee, Senegal National Agricultural Bank (CNCAS), and National Agriculture Insurance Company of Senegal (CNAAS)	The main partner is SAED. Joint Coordination Committee and Master Plan Task Force included MAER, the Agricultural Bank (LBA)[5], ANCAR, AfricaRice, ISRA, Regional Directorate of Rural Development (DRDR), Interprofessional Committee of the Senegalese Rice Sector (CIRIZ), Office of Lakes and Watercourses (OLAC), etc.

(Adapted from USAID 2019 and JICA 2021)

The two projects were chosen for their overlap in the target zone (Senegal River Valley Delta, mainly Dagana and Podor district of Saint Louis region) as well as the target crop (rice), and their breadth of intervention (production to marketing). For the purpose of this investigation, the main focus of the analysis of Naatal Mbay will be its activities and impacts on rice value chain in the SRV, even though the overall project had a wider scope.

[5] Formerly Senegal National Agricultural Bank (CNCAS)

IV. Functional Analysis

(1) Knowledge Development and Diffusion

Naatal Mbay

Naatal Mbay contributed to the knowledge diffusion dimension of the AIS in SRV by working with producer networks which integrated farmer-owned and farmer-led extension systems. In partnership with the Senegalese Association for the Promotion of Bottom-Up Development (ASPRODEB), the knowledge development and diffusion network system comprised 167 database managers, 771 network field agents, and 3,882 lead producers. The most productive and influential producers were identified by the network and encouraged to share and discuss learnings among their members. Naatal Mbay first trained technical teams from the producer networks (i.e. database manager, facilitators, and lead producers) in key topics. The trainings were structured as a combination of Training of Trainers (ToT) supported by producer networks and direct training provision to certain groups. These trainings aimed to increase adoption of conservation farming practices to adapt to climate change, and to strengthen the network capacity to manage services such as coordination for group input purchases, harvest services, and mechanization services, negotiation for input loans, management of seed multiplication and monitoring of production and rainfall data. Knowledge diffusion was made also through community radio broadcasts, which summarized the key production and marketing information that was shared in seasonal debriefing sessions with the networks at the end of each season.

Naatal Mbay also worked on data driven knowledge generation. The networks were trained in collecting and utilizing digital information systems to track farmer

performance and technology adoption, allowing data to be reflected to their decision making. For example, the networks were trained in Global Positioning System (GPS) surveying, rainfall tracking, spreadsheet management and cloud information assessments, and used these data to generate loan applications and marketing forecasts. This new farmer knowledge base of tech literacy created the foundation for the introduction of digital tools, such as the CommAgri app developed by Dimagi, a tech company. The development of ICT enterprises will be detailed in (5) Entrepreneurial Activities and Experimentation.

Another important category of knowledge generated and diffused in Naatal Mbay is the climate and weather information. Climate data was collected through 303 manual rain gauges, set up in partnership with ANACIM and managed by the producer networks themselves. Rain gauge managers were trained on installation standards and rainfall-recording techniques by ANACIM. Naatal Mbay further supported the dissemination of climate and weather information by piloting Météo Mbay, a USSD system developed in collaboration with ANACIM and Amandjine Consulting. The system included 4,257 members and was managed by 34 rain gauge managers who transmitted forecast information from ANACIM and rainfall data from the rain gauges via SMS to their immediate communities. Local authorities and DRDRs were also connected to the system, allowing the key stakeholders to improve decision making with real-time information. In addition, to increase the legitimacy of the use of climate and weather information to inform farming operation, Naatal Mbay partnered with CINSERE, ANACIM and the DRDRs to establish 62 demonstration sites. The plots that utilized climate information gained up to 25% higher yields. As a

result, 102,803 farmers were applying risk-reducing practices and accessing climate information in the project's final year.

PAPRIZ2

In PAPRIZ2, a participatory method of small-scale maintenance of irrigation scheme and water management was disseminated through a series of Training of Trainer (ToT) activities, and were monitored through a feedback mechanism that connected field level activities to the valley wide guidelines. After an initial analysis of challenges regarding the maintenance of irrigation facilities, PAPRIZ2 updated the existing guidelines for the operation and management of irrigation facilities and water management and disseminated them through a ToT to SAED extension agents. In collaboration with the SAED department offices, the guidelines were then translated into action plans, selecting two model districts, where SAED extension agents would conduct ToT to lead producers, who would then conduct trainings to other farmers in neighboring districts. After the series of ToTs, feedback mechanism came into effect; each district developed an operation and management plan under the supervision of SAED extension agents, and conducted a workshop at the end of the year to reflect on the results and to plan for the following year. Based on the results of these field level activities in the districts, SAED department offices revised its action plans. The guideline for the entire SRV was also revised again and received approval from SAED headquarters. As SAED extension agents are spread thin to oversee multiple irrigation schemes, it was effective to conduct ToTs to lead producers to maximize SAED resources. The project also reported higher engagement from the participants when the

trainer was a producer themselves, as they were able to draw upon their own experience to give more legitimacy to the training content. Moreover, the action plans developed at the department level helped to create a sense of ownership by the SAED extension officers to monitor the district activities and reflect on the future.

PAPRIZ2 also revised the way in which extension activities for irrigated rice were conducted by the SAED in two ways. Firstly, PAPRIZ2 created an extension monitoring sheet to allow SAED extension workers to visualize the results of technology dissemination, and for the SAED headquarters to collect standardized data across the departments. Previously, SAED had difficulty in evaluating the implementation status of technology dissemination due to the lack of an established monitoring system. The monitoring sheet developed in the project was later integrated to a pilot project for ICT use, to allow efficient and prompt aggregation and analysis of the monitoring results. Secondly, PAPRIZ2 put together teaching materials for FFS and conducted ToT to SAED extension workers as well as the FFS to producers in several districts. The project concluded that FFS is an effective means of extension in the SRV, but noted several recommendations:

a) *Size of demonstration farm*: As large demonstration farms are difficult to manage, it is recommended to select small-scale farms as demonstration sites for FFS.
b) *Target population*: As landless farmers receive instructions from the landowner, it is difficult for them to implement changes in farming practices after FFS. It is recommended to target farmers that own their land, or to invite both the landowners and the farmer to the FFS.

PAPRIZ2 also conducted trainings for agricultural machinery service providers on business and technical skills such as operation and maintenance of tractors and combine harvesters for machine operators and accounting and business skills for managers. The machinery training was instructed by a local mechanic, who trained one of the young private operators who attended the trainings to eventually take over the training sessions. One hundred and four (104) of 127 service providers identified in the department of Dagana and Podor attended the trainings. One of the difficulties in approaching mechanization in SRV through SAED was its lack of mandate over the issue. Although the SAED had no jurisdiction over mechanization and had no department designated for the issue, as the Directorate of Rural Equipment Modernization (DMER) of the MAER does not have a branch office in the field, the SAED had to deal with issues such as inquiry on regional specifications of machineries on a case-by-case basis without any local mechanization strategies. As PAPRIZ2 continued to work on the service provider trainings in close collaboration with SAED staff, SAED management recognized the importance of activities in this area and appointed a new staff in charge of mechanization. It can be said that the knowledge development and diffusion efforts led to human resource mobilization. The agricultural machinery services are mostly operated by private actors. However, with this appointment and further financial resource mobilization, it is hoped that the SAED will be able to take the lead in enhancing the AIS through activities such as improvement of regulatory environment and ensuring quality of service.

(2) Resource Mobilization

Naatal Mbay

As mentioned in (1) Knowledge Development and Diffusion, Naatal Mbay has been successful in network mobilization, through significant investment to producer networks, directly involving more than 120 farmer networks in project implementation. The networks now interact with the entire value chain (such as the input and rice markets), coordinate seed multiplication and distribution, and facilitate access to credit and insurance. Several network leaders have become strong sectoral advocates, capable of interacting with the authorities, financial institutions, and the private sector and conducting evidence-based negotiations.

Naatal Mbay has made significant strides in terms of product mobilization, namely facilitating access to quality seed. There are three components to the intervention:

a) *Triennial seed plans*: Seed multiplication targets pegged to desired production levels and matched with multiplication capacity were indicated in the triennial seed plans. The participating actors (i.e. research institutions, private seed operators, seed multipliers, seed production centers, seed sorting centers) utilized the plans to organize their resources.
b) *Seed production and certification*: The project upgraded infrastructure such as seed processing centers and quality testing laboratories.
c) *Promotion of seed distribution networks*: In partnership with two private seed cleaning and sorting companies in Kaolack and Kolda, the project developed a geo-referenced map of seed distribution points., which were used as the basis for development of a new distribution system. The managers of these

distribution points were trained and linked to seed-cleaning and sorting companies.

One of the most significant impacts Naatal Mbay had on the AIS of SRV is its contribution to financial resource mobilization. In the integrated financing system, banks grant credit to producer networks to finance inputs based on the network's pledge to repay in-kind at harvest. To repay, the network producers deliver a volume of paddy rice corresponding to the value of the loan reimbursement to a designated warehouse[6]. The producers' in-kind repayments are then acquired by rice mills that have a procurement line of credit with the banks. When the rice mill signs a purchase agreement with the producer network, the bank activates its line of credit to settle the account of the producer network. The rice mill's credit is then secured through the rice it purchased[7]. This model places the loan at the center to coordinate both farmers and rice millers, using rice as a collateral. It has brought loan defaults to less than 5% for farmers and less than 1% for rice mills. It allows farmers to enter engagements with technical and financial independence, and increases rice mills' sourcing capacity. CNCAS has made this system a condition to access marketing lines of credit, pushing millers who did not have the infrastructure to invest in quality storage. Naatal Mbay has provided trainings to build the capacity of producers to apply for and receive timely loans, and banks to minimize risk and to expand their lending portfolios to be

[6] The final volume of paddy rice to be repaid is calculated based on a reference price negotiated at harvest, adjusted to the market. The reference price negotiation are chaired by the SAED, attended by the bank, producer networks, and the rice mills. CNCAS auditors monitor the repaid rice paddy, and validate the data provided by the warehouse managers.

[7] The rice millers' lines of credit are not limited to rice from the producer repayment; the collateral system can also be used to procure surpluses from individual farmers, producer networks, stocks held by mechanized service providers from in-kind payments by farmers, or by private paddy rice consolidators. Prices are determined by ad hoc negotiations. Invoices are settled by bank transfer.

more inclusive. The project focused on producer networks that historically struggled to access credit or those that had outstanding loans, through diagnosis of their financial situations, reopening of negotiation with CNCAS to restructure existing loans to allow repayment and to regain good standing with the bank. In addition, in partnership with SAED, Naatal Mbay also revitalized local credit and collection committees to mitigate producer lending risks for the CNCAS by redefining the roles and missions of the committees in Dagana and setting up new ones in Podor and Matam.

PAPRIZ2

PAPRIZ2 worked on better asset mobilization of rice paddy warehouses. In order to improve the quality of paddy, paddy moisture meter was provided to SAED extension agents and paddy moisture management training was conducted. The extension agents then developed a paddy warehouse monitoring plan and provided guidance to their responsible unions and GIEs regarding appropriate management of paddies in existing warehouses. In addition, PAPRIZ2 conducted a study on the capacity of paddy warehouses in the department of Dagana and Podor. According to this study, the capacity of the paddy warehouse is insufficient in the area, forcing about half of the producers to store their paddy outside, significantly reducing the quality of the paddy, and hence the quality of milled rice. This limits the efficiency of rice millers because they cannot achieve the full capacity of the rice milling equipment, as they are forced to mill the paddy immediately after harvest, causing seasonal fluctuation in volume. PAPRIZ2 submitted the study to SAED, and

recommended the appropriate paddy storage capacity and location to increase the quality of paddy rice and the profitability of rice millers.

PAPRIZ2 also intervened in financial resource mobilization and land asset optimization in the context of double-cropping[8]. After a series of interviews and workshops with the unions and GIEs, PAPRIZ2 proposed a double cropping system which was composed of three elements: a) strict adherence to the cropping calendar, b) block management of sites to ensure efficient workflow and machinery availability, and c) securing a year-long loan from the LBA (instead of a seasonal loan to avoid delay in securing the loan for the second season). PAPRIZ2 and SAED established three pilot sites and designated five more sites as extension sites where unions and GIEs received trainings on double-cropping system. As a result, two out of three pilot sites and two out of five extension sites succeeded in double-cropping. Although the reason for low productivity of rainy season rice needs further investigation and the water management needs to be enhanced by improving the quality of irrigation facilities before the double-cropping system can be disseminated widely, the impact the project had on financial mobilization was noteworthy. Before the project, unions and GIEs needed to reapply for a loan between two seasons in order to conduct double-cropping. However, loan application could only be started after repayment of loan with harvest from the first season, and the approval took too long to secure land preparation services in a timely manner. Faced with this dilemma, PAPRIZ2 discussed potential solutions with the LBA, and were able to secure a year-long loan for the pilot

[8] Farming for two harvests of rice in a year. In the SRV, rice is typically cultivated only during the dry season, despite the possibility of double-cropping if under irrigation.

and extension sites. In fact, the LBA had already considered developing a year-long loan as a new financial product, but were hesitant to test it on its own. PAPRIZ2 was able to reduce the risk of the experimentation of the new financial product by providing training in double-cropping system to the selected sites.

(3) Guidance of Search

Naatal Mbay

Naatal Mbay worked with SAED on a proposal to improve transportation and logistics in the SRV, entitled “Boucle du Riz” (the Rice Ring Road), which identified priority routes to support rice transportation between the field, the warehouses, and the rice mills. It also indicated the distance to be rehabilitated and paved, as well as the storage locations for CNCAS loan reimbursements. In partnership with ASPRODEB, CIRIZ, UNIS-NORD, and CNCAS, Naatal Mbay also proposed a seed-specific strategy to address the issues of access to finance for seed multipliers, whose production cycle is longer than conventional rice production.

PAPRIZ2

PAPRIZ2 supported the development of the Rice Sector Master Plan (2018-2027) in the SRV. PAPRIZ2 established a task force comprised of the SAED, the LBA, ANCAR, AfricaRice, ISRA, DRDR, CIRIZ, and OLAC for formulating the Master Plan, strengthening cooperation between organizations, and sharing progress of implementation. In partnership with the SAED, the project conducted data analysis work and problem identification workshops in each departments, and compiled the

result to identify core challenges in the rice sector of the SRV. Based on this analysis, a development scenario was created, which served as a basis for the development strategy and priority programs/projects, which were compiled as a draft Master Plan. The draft Master Plan was approved by the task force, then by the MAER, which conducted a seminar to raise awareness among related organizations and donors. Interventions by donors in the SRV has begun to fall in line with the Master Plan, giving more control for prioritization of projects to the SAED.

(4) Market Formation

Naatal Mbay

In partnership with the Ministry of Commerce, the MAER, and the SAED, Naatal Mbay supported group marketing through regional and international fairs such as the International Fair of Dakar (FIDAK) and the International Agriculture and Animal Fair (FIARA). This helped to build relationships between wholesale traders and industrial rice millers. Initially, Naatal Mbay provided Feed the Future–branded booths and banners for partners to display their products and conduct business negotiations. However, by the second year of the project, Naatal Mbay handed over the responsibility of organization and management for these events to the National Rice Association (ANR), so that the companies behind the rice brands can take advantage of the exposure and take ownership. These events served not only as important occasions to build market linkages, but also as advertisement opportunities to raise awareness among urban consumers on the newly enhanced quality of Senegalese domestic rice.

Naatal Mbay and PlaNet Guarantee worked with CNAAS to develop tailored insurance products and to educate producers, insurance staff, and financial institutions on the risk- mitigation strategies. By the final year of the project, agricultural insurance subscriptions reached 34,854 producers, an increase of over 140% compared to the first year the project. Agricultural-micro insurance was also integrated into rice input credits. With 24,268 subscribers covering 26,036 ha, the micro-insurance product contributed to increased input access and hence to production increases of irrigated rice. However, the administrative costs of this product were considered too high. To identify alternatives, Naatal Mbay piloted a yield-indexed insurance for irrigated rice in the Matam region. Although the project ended before scaling the yield-indexed insurance, CNAAS plans to launch the new product to farmers across Matam, Podor, and Dagana.

PAPRIZ2

In order to revitalize the business of agricultural machinery service providers and improve customer satisfaction, PAPRIZ2 established a network of agricultural machinery service providers in the department of Podor, which included 47 private companies or producer organizations. In addition to the trainings described in (1) Knowledge Development and Diffusion, PAPRIZ2 conducted a business expansion seminar, introducing agricultural financial products and holding individual consultations between financial institutions and participants. These networking opportunities led to successfully lobbying for an agricultural machinery spare parts agency to open in the department of Podor. This was an important win for the network

members, because sourcing spare parts from Saint Louis or Dakar had always been a bottleneck in timely repair to maximize equipment use.

The demand of the network has also been reflected in the SRV Agricultural Mechanization Strategy (2018), which emphasized a) private sector driven development, b) introduction of small agricultural machinery, and c) promotion of capacity building for the maintenance of agricultural machinery. Facilitated by PAPRIZ2, the strategy was developed by a committee comprised of representatives from the SAED, the MAER, agricultural machinery service providers and producers. In the SRV, the number of agricultural machinery service providers has increased by about 2.5 times between 2017 and 2021. PAPRIZ2 recommended that the Senegalese government provide tax incentives and subsidies for agricultural machinery and spare parts procurement in order to continue the expansion of the sector.

(5) Entrepreneurial Activities / Experimentation

Naatal Mbay

New value chain practices introduced by Naatal Mbay have created opportunities for IT services. As mentioned in (1) Knowledge Development and Diffusion, CommAgri app was developed as a data collection and monitoring tool for producer networks. For 55% of the participating networks, the Excel-based databases were considered sufficient for their purpose. However, when a group of more active and engaged producer networks requested a digital app for easier data entry, reduced delays and entry errors, and increased analytic capacity, a digital adaptation was piloted with the support of Dimagi, a tech company. The resulting application,

CommAgri, incorporated the data collection and sharing function with the mapping capability. The app's function ranges from a rice stock tracking tool to a real-time local rainfall and USSD/SMS weather alert. At the time of project close, more than 56 networks were using CommAgri, covering more than 60,587 farmers.

As a private pilot initiative, Dimagi established local agents to collect fees from farmers to build a direct service provider relationship with the networks. The pilot revealed that the producer organizations were not inclined to pay for the service out of their membership fees or sales commissions despite their appreciation for the service. However, private actors such as the financial institutions, insurance companies, and input suppliers expressed interest in the farmer-generated data. CNCAS and CNAAS, local financial institutions, are now considering developing the CommAgri app to a customer service platform to manage credit and insurance applications by farmer organizations. Local IT tech firms such as SIS'TECH, Stat Info, Daris, and Amandjine Consulting have also developed applications for Naatal Mbay, and have been adopted by value chain stakeholders beyond the project period to pursue and expand their services.

PAPRIZ2

PAPRIZ2 conducted a field trial of small-scale machinery in the department of Podor to test their applicability in the environment of the SRV. Four irrigation districts were selected to test a reaper and a brush cutter on two occasions. As a result, it was concluded that reapers can contribute to timely harvesting in irrigated areas where seasonal workers are scarce, by reducing the required labor. The project worked to

improve the reaper's transportation method, as the efficiency of the machine's work per day is greatly reduced when the field and the storage location is far away from each other, as the reaper takes time to travel in a self-propelled movement. In order to improve transportation efficiency and reduce labor, PAPRIZ2 introduced a prototype using a temporary wooden board to transport it to a horse-powered carriage. However, other issues were also identified, such as the low durability of reapers that can be procured in Senegal, and the shortage of operators and mechanics who were familiar with a reaper. The project recommended the following to DMER:

a) Introduce small to medium sized machinery east of Podor, due to the small farm size.
b) Utilize reapers in an irrigated area where rice is cultivated by row sowing.
c) Conduct performance test before the procurement of reapers, focusing on work efficiency, operability, etc., in collaboration with SAED staff who participated in the PAPRIZ2 test.
d) Conduct training on operation, maintenance and repair to stakeholders in and around the selected irrigation district.
e) Implement of on-site application tests before full-scale introduction
f) Impose regulations to make spare parts supply network and maintenance service mandatory
g) Utilize of human resources from research institutes and the private sector to formulate and evaluate plans that reflect the situation on the ground.

The project recommended the following to the SAED:

a) Strengthen policy ties with DMER to implement activities in line with the Agricultural Mechanization Strategy.
b) Update the agricultural machinery inventory and agricultural machinery standard specifications and discuss necessary policies with DMER
c) Secure funding necessary to updated agricultural machinery

(6) Creation of Legitimacy

Naatal Mbay

Naatal Mbay provided technical support to Government of Senegal and the International Finance Corporation (IFC) to invest in the development of a warehouse receipt system (WRS) to reduce post-harvest losses, regulate prices, and attract more finance to agriculture. In an effort to create institutional legitimacy, Naatal Mbay participated in a working group to establish a legal and regulatory framework for WRS. During the WRS pilot program in the SRV, nearly 50 tons of rice was deposited at the WRS site by producers. An evaluation of the pilot WRS confirmed that a WRS for the SRV is feasible and represented an opportunity to transform commercial transactions along the value chain.

Naatal Mbay also introduced a tracking system for aggregated rice stocks and in-kind loan reimbursements. Under this digital system, credit repayments are monitored using a digital information platform first developed by SIS'TECH. Improved access to reimbursement tracking, along with a warehouse inventory-tracking system developed by KAMEX, a local audit firm, tracked credit repayments easily and helped speed up loan approval for the following season. In addition to

informing credit decisions, the data system also monitored 150,000 tons of paddy per year by the Ministry of Commerce, providing evidence to policy makers regarding local rice production and marketing levels, another example of institutional acceptance.

One of the technical components of Naatal Mbay was to create an information exchange platform between local and national policy makers. The project established close links MAER's regional directorates and governing institutions through seasonal debriefings and the involvement in producer networks in local committees. At the national level, Naatal Mbay participated in the PSE Cereal Corridor working group, a committee made up of government agencies and private-sector organizations that oversaw the subcomponent of the national development strategy. This enabled Naatal Mbay to routinely share new developments in the cereal sector with policy makers. The working group expressed interest in the SRV contracting system, along with the "Boucle du Riz" (the Rice Ring Road) transport infrastructure proposal. Having a seat at these platforms allowed Naatal Mbay to articulate its findings to policy makers, creating institutional acceptance and contributing to legitimacy in its findings.

PAPRIZ2

As mentioned in (3) Guidance of Search, PAPRIZ 2 supported the development of the Rice Sector Master Plan (2018-2027) in the SRV, which was eventually approved by the MAER. The project supported the institutional acceptance of their findings in the form of validation of the strategy document.

Another example for creation of legitimacy can be found in the creation of social acceptance for the value in quality seed among the seed farmers. Low seed quality is one of the main factors hindering the improvement of irrigated paddy rice yield, especially in the department of Podor. To tackle this issue, PAPRIZ2 prepared a seed production manual and conducted seed producer trainings in seed production techniques and varieties in high demand. As a result, the pass rate of seed inspection improved in the department of Podor, as the seed producers understood the importance of increasing seed quality in relation to increase their income. PAPRIZ2 established a network of seed producers to promote seed self-sufficiency, mutual information sharing, production of quality seeds, and distribution within the region, further contributing to the social acceptance of the value in quality seed production. Institutional legitimacy of seed production is slightly complicated, as seed production falls under the jurisdiction of the MAER Seed Division (DISEM) at the central level and the DRDR and the SDDR at the local level. The main function of these institutions are field inspections and quality inspections of produced seeds, but do not include providing technical guidance on seed production. As an institution with extension agents on the ground, SAED needs to cooperate with these organizations to improve seed production.

In addition to conducting trainings and forming a network, PAPRIZ2 established a demonstration site for newly registered varieties developed by ISRA. The project held a variety show at the demonstration site for producers in the surrounding area and collected their preference. This information was then shared back to ISRA, which is responsible for the production of foundation seeds. As no

organization is responsible for cultivar dissemination, the new varieties had been largely unknown to seed producers and farmers. The demonstration farms were effective in providing visual reference for the farmers to understand the characteristics of new varieties, but also to create a feedback mechanism to ISRA regarding the desired varieties.

V. Conclusion

Naatal Mbay and PAPRIZ2's contribution to the AIS function of knowledge generation was mostly based on human capacity development. For PAPRIZ2, all knowledge generation activities were conducted in close collaboration with SAED staff. Although the extent to which the knowledge generation functionality has been institutionalized in the SAED is difficult to measure, it can be said that the SAED staff has gained the capacity to conduct knowledge generation activity in the future. On the other hand, Naatal Mbay was able to put in place a more systematic knowledge generation mechanism in the form of data collection and use. The capacity development in data literacy further brought the opportunity to introduce ICT tools, expanding entrepreneurial activities.

While Naatal Mbay approached the knowledge diffusion through partnership mainly with the producer networks and the private sector, PAPRIZ2 mainly partnered with the public sector. Working on mechanization issue with SAED posed a challenge with jurisdiction for PAPRIZ2; however, it was able to instigate institutional change and resource mobilization. Although it is difficult to say which approach is better, involving a wide variety of actors seems to be the key. ToT is the dominant approach

for knowledge diffusion in both projects, and they have both achieved good results. It is also notable that both projects emphasized putting in place a feedback mechanism for reflection. In the case of Naatal Mbay, seasonal debriefing sessions were conducted among the producer networks, and key production and marketing information was disseminated via radio. In the case of PAPRIZ2, operation and management plans and results of each irrigation district were reflected at the end of the year, informing the revision for department level action plans.

Resource mobilization within the two projects seemed to have well targeted the weak points of the AIS in SRV that were limiting its potential: Naatal Mbay improved quality seed access for smallholder farmers, and PAPRIZ2 enhanced management of paddy warehouses. Although the integrated financial system described above in (2) Naatal Mbay was groundbreaking, PAPRIZ2 found points in the system that can be improved. As international donors have more financial resources and risk absorption capacity, it seems natural for them to be the catalyst financial mobilization.

Both projects intervened in the guidance of search function of the AIS, by facilitating the relevant actors to articulate and harmonize visions and strategies for the future. While PAPRIZ2 supported the development of a Master Plan at a sector wide level, Naatal Mbay intervened at a thematic level on matters of transportation and seed. Although the development of these strategy documents can easily be presented as a project outcome, it is important to note that plans and strategies require constant revision based on realities on the ground. Unfortunately, it is unclear through the project reports whether the projects were able to build the capacity of the actors in the

AIS to monitor the progress of the plans and continue to revise the future visions of development.

In terms of market formation, regional and international fairs could play an important role, especially for network building and providing access buyers and consumers who had not been made aware of the recent quality improvement of domestic rice. The insurance product developed by Naatal Mbay was widely used, preparing the market for more products, by increasing the financial literacy of farmers. In the case of PAPRIZ2, the mechanization service market was revitalized through the establishment of a network. Although concrete commitment has not yet been made by the Government of Senegal, institutional stimuli such as tax incentives and subsidies or standards for machinery specification may drive further development of the market.

Naatal Mbay created opportunities for entrepreneurial activities of IT companies in the SRV by contracting out the development of ICT tools and by building their future customer base and through development of farmers' IT literacy. PAPRIZ2 conducted experimentation with a reaper and proposed further performance test to DMER and SAED. Impressed by the trial results, SAED and MAER officials requested for the procurement of reapers to the Japanese government soon after the recommendation by PAPRIZ2. Although neither of the projects' examples can be said to have genuinely provided space for experimentation and social learning of the AIS actors in SRV, they certainly did provide a favorable environment for future entrepreneurship to take place.

In terms of creation of legitimacy, Naatal Mbay's active sharing of study data in national and local platforms contributed to institutional acceptance of project results.

As the institutional acceptance for seed production techniques seemed complicated due to divided jurisdiction between inspection and extension, PAPRIZ2's approach of emphasizing social acceptance was effective, through building a network of producers and establishing a site for demonstrating tangible results. Establishing demonstration farms also contributed to demand articulation of seed producers and farmers regarding new varieties.

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CHAPTER 3: THE ROLE OF PRIVATE SECTOR

I. Introduction

In an increasingly complex agriculture sector in developing countries, the top-down "transfer of technology" model of the public agricultural extension during the Green Revolution no longer applies. Current literature examines options for public extension reform in the context of AIS, "a network of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into social and economic use," (World Bank 2007) with "formal and informal rules that condition their behavior" (Oliveira 2018). As discussed in Chapter 1, many cash-strapped developing countries are moving away from the sole dependence on public extension systems to a more pluralistic system where the private sector also plays an important role. In fact, as developing countries become more integrated into the global food market, their production systems have become specialized, requiring context and commodity-specific extension services, which public extension systems have difficulties providing with what is often a one-size-fits-all approach. Instead, contract farming and input suppliers increasingly provide opportunities for farmers to access private extension services.

In this changing landscape of agricultural extension, this chapter explores the question: "how can the private sector meet the extension needs of smallholder farmers in developing countries?" This chapter will first explore the role of the private sector in the AIS. Then, two case studies from Kenya are analyzed to examine the role of the private sector in its AIS. The case studies are analyzed using the revised evaluation

criteria of interventions (2019) set by the Organization for Economic Co-operation and Development (OECD) Development Assistance Committee (DAC).

II. Role of Private Extension in the AIS

(1) Rise of Extension and Advisory Services Provided by the Private Sector

Agricultural extension is a crucial connection that facilitates the process of scaling agricultural innovation into durable improvements, as farmers adopt, adapt, and innovate with new technologies and practices. During the Green Revolution (1970-1990), the public extension system significantly contributed to advancing knowledge, skills, and productivity of farmers. Even now, studies have shown that the rates of return of public expenditures on extension services are higher than those on input subsidies, averaging 85 % (Davis 2020).

However, public extension services are often criticized for their lack of efficiency and effectiveness, as mentioned in Chapter 1. During the structural adjustment period of the 1980s and the 1990s, fiscal realities and pressures from the International Monetary Fund and the World Bank led many developing countries to cut public spending on extension services, as it was an attractive target due to their high recurrent costs, unorganized client demand, and unclear short-term benefits. Programs such as the training and visit system were criticized for their inefficiency, inability to reach women farmers, and lack of financial sustainability. While public extension programs were at peak staffing from the expanded programs during the Green Revolution (1970-1990), there was donor fatigue in extension, shifting funding to private nonprofit and for-profit extension service providers. The global rise of the private sector extension

services was also enabled by the reduction of heavy-handed government control over agricultural input and output marketing, expansion of diversity in the sources of agricultural research, and increased access to international trade. The private sector accounts for slightly more than 8% of extension agents globally, according to the 1991 and 2012 survey results analysis made by International Food Policy Research Institute (IFPRI) (Davis 2020).

(2) Types of Private Extension Services

In general, there are four major ways in which smallholder farmers in developing countries access private extension services: contract farming, agricultural input and commodity firms, producer cooperatives, and fee-for-service agencies.

a) Contract Farming

Extension and advisory services provided in contract farming are often high in quality and intensity, as both the farmers and the buyer have the market incentive to adopt the specified agricultural practice and technology to reduce rejected produce. The relevance of the extension content is high, as the advisory is focused on the specific type of variety the buyer purchases. However, there is a downside that farmers may lose autonomy over farm management decisions and become dependent on a single buyer. Farmers generally have little choice over the content or the nature of extension, although this may depend on the power dynamics between the firm and the farmers. Buyers' selection bias against marginal farmers who have higher extension needs also acts as an access barrier.

b) Agricultural Input and Commodity Firms

The extension service provided as part of the marketing activities of agricultural input and commodity firms may either be limited to their customers or provided as an inducement to become a customer of the firm. For example, a tractor company in India, Mahindra and Mahindra Ltd., offers fee-per-area extension services through its dealerships and franchisees. The services include the sale of inputs, credit arrangement, field visits by a professional and produce procurement, aimed at rice, sugar cane, maize, and wheat. While the quality of extension services varies depending on the firm, the services are largely concentrated on areas with good infrastructures to minimize product distribution costs. The content of the extension also faces a dilemma of not being able to promote better products offered by rival companies.

c) Producer Cooperatives

Access to private sector extension can also be initiated from the farmers' side, for example, through producer cooperatives or commodity associations organizing extension services for their members. For example, a Rice Producers' Federation in Colombia funds adaptive research and extension, in which farmers can participate in identifying priorities and evaluating results. While the content of the extension tends to be the most relevant for farmers, the financial sustainability of this model can be a challenge.

d) Fee-for-service Agencies

Fee-for-service agencies are common in the livestock subsector, in the form of veterinary services, as herders are willing to pay for high quality advice and products for their animals, which is an important source of income and savings. For example, paravets trained by Actionaid//Vetaids in the 1990s that provided fee-for-service advisory and veterinary drug sales were popular even among resource-poor herders in Somaliland. However, it must be noted that the emergence of privatized services are often dependent on an enabling policy environment, such as the lack of regulation or subsidised public services.

(3) Private Sector Extension in the Context of Agricultural Innovation System

With the rise of uncoordinated individual services in different agricultural value chains and the expansion of ICT advisory and the outreach of lead farmers, the role of extension agents has become less clearly defined. The globalized market and the growth of commercial agriculture created niche innovation needs that could be addressed by the private sector. While many public extension agents are targeting small-scale, often subsistence farmers, there are many cases of duplication and lack of coordination with the private extension services. The public sector now has the role of overall coordination and regulation of the pluralistic extension system, including the linkages between extension services, research, and farmer feedback mechanisms. However, many countries lack an explicit policy outside of a broad agricultural development strategy. In addition, the pure demand-driven extension of the private

sector fails to address social objectives, such as promoting environmentally sustainable practices. This is not only because the private extension services are driven to emphasize economic grain rather than social causes to ensure their return on investment, but also because of the lack of demand from the farmers. The private extension services naturally tend to focus on issues that have the highest immediate payoff to farmers, as farmers express lower demand for long-term environmental management issues. For the AIS to function, there is a need for a policy basis with the overall framework to achieve the best outcome for society.

(4) Conceptualizing Public and Private Extension

In welfare economics, a public good is non-excludable and non-rivalrous. Excludability refers to a condition in which access to goods is denied to those who have not paid for the product. Rivalry refers to a situation in which one person using the goods reduces the availability of the goods to others. Umali and Schwartz (1994) categorized the types of agricultural information into four different categories (Table 3-1): “public good” (non-excludable and non-rivalrous), “private good” (excludable and rivalrous), “common-pool” (non-excludable and rivalrous), and “toll-good” (excludable and non-rivalrous). In this categorization, long-term general agricultural information, and large-scale information such as market prices fall under “public good”. Information that requires the use of a purchased modern technologies and/or legal mechanisms that create high excludability such as tailored soil management advice or instruction on the use of a particular pesticide are classified as “private good”. Time-sensitive information that farmers are willing to pay, such as information

on the management of common grazing resources of improved agricultural technologies are categorized under "common-pool." Pure agricultural information, a type of information that can be used without access to physical technology, such as cultural and production practices, as well as specialized agricultural information such as farm management, marketing, and processing, fall under "toll-good." Umali and Schwartz suggest that the private sector can supply the excludable agricultural information ("private good" and "toll-good") at socially optimal levels.

Table 3-1: Classification of Agricultural Information and Technologies that Extension System Handles

	Excludable	Non-excludable
Rivalrous	**Private good:** Modern technologies (machinery, chemicals, and hybrid seeds) Information on commercially available inputs Client-specific information/advice	**Common pool:** Improved agricultural technologies (fertilizers, modern seed varieties, irrigation) Information on locally available resources/inputs
Non-rivalrous	**Toll-good:** Pure agricultural information (cultural and production practices), Specialized agricultural information (farm management, marketing, and processing) Time-sensitive information	**Public good:** Long-term general agricultural information Large-scale information (market prices) Time-insensitive information with wide applicability

(Adapted from Umali and Schwartz 1994 and Chapman and Tripp 2003)

However, the success of private extension services is much more complicated than the theory suggests, due to the inherent difficulty in making information an excludable commodity, and the market imperfections that reduce social welfare. If the access to information on new technologies cannot be restricted only to their customers, the information will be shared freely, preventing the private sector from gaining profit from the extension service it provides. Moreover, if farmers are unaware of the value

of the information and the benefits are not easily observed, then market establishment for the service will be a challenge. Furthermore, in market imperfections such as the prohibitive costs of reaching remote areas or the failure to provide affordable services to smallholder farmers, the private sector will not be able to address the diverse, subsistence-based, needs of the majority of resource-poor farmers in developing countries. Positive externalities such as promoting environmentally sustainable practices or improving soil health may need to have the public sector involved to spread the knowledge more widely.

III. Case Studies

(1) Methodology

OECD DAC's evaluation criteria of interventions are often used to evaluate projects or programs conducted by a public institution. However, according to OECD DAC's evaluation guide, the term "intervention" broadly signifies the topic or object of the evaluation, including the activities of the private sectors. In this chapter, the intervention is defined as the provision of extension services by the private sector entity (and not the entity's business as a whole). The six evaluation criteria used in this paper are defined as follows:

a) Relevance: "Is the intervention doing the right things?" (OECD 2021)
   Relevance considers whether the intervention responds to the needs and priorities of the beneficiaries.
b) Coherence: "How well does the intervention fit?" (OECD 2021)

Coherence determines the compatibility of the intervention with other interventions. Internal coherence considers the consistency of the intervention with relevant international standards that the intervening actor adheres to. External coherence addresses the complementarity and coordination of the intervention with other actors' interventions in a similar context.

c) Effectiveness: "Is the intervention achieving its objectives?" (OECD 2021)
Effectiveness addresses whether the objective of the intervention was achieved or not.

d) Efficiency: "How well are resources being used?" (OECD 2021)
Efficiency considers whether the intervention delivers results in an economical and timely way.

e) Impact: "What difference does the intervention make?" (OECD 2021)
Impact addresses the ultimate significance of the intervention or the intended or unintended higher-level effects.

f) Sustainability: "Will the benefits last?" (OECD 2021)
Sustainability determines the likelihood of the net benefits of the intervention to continue over the medium to long term.

(2) Case Study 1: Kenya Horticultural Exporters Ltd. (KHE)

Established in 1977, KHE is one of Kenya's leading exporters of vegetables and fruits. The company mainly exports French beans to the United Kingdom (UK), France, and the Netherlands, totaling 5,500 tons of produced goods annually. KHE operates two farms with a total of 690 ha in central Kenya and an out-grower scheme

with over 2,500 smallholder farmers. KHE provides inputs, specifications, training, and sometimes credit to its outgrowers, who, in turn, provide set quantities of produced goods at pre-negotiated prices. In this case study, the objective of the intervention is to increase the productivity and quality of outgrowers' production, and the beneficiary is defined as the KHE outgrowers.

a) Relevance

Horticulture is the third largest foreign exchange earner for Kenya that directly employs about 350,000 people and supports over six million livelihoods (FPEAK 2021). French bean is Kenya's largest vegetable export crop by far, and accounted for 19% in volume and 16% in value of the total fresh vegetable exports in the first half of 2021 (HCD 2021). The French bean supply chain engages 50,000 smallholder farmers with less than 2 acres of land, accounting for 77% of the total national production. It employs up to 60,000 people in commercial farms, processing, and logistics operations (Zhou 2015). French bean is an essential crop for smallholder farmers due to its high profitability[9], short maturity[10], flexible year-round planting, and rotation compatibility with other high value crops such as baby corn. However, the increasingly stringent quality regulations of the European Union (EU) market put Kenyan smallholder farmers at a disadvantage if left without extension support to comply with the food safety standards. The public extension system in Kenya cannot provide this service due to the lack of manpower, up-to-date knowledge, financial resources, and transport facilities. Therefore, KHE providing its outgrowers with

[9] French beans are said to be seven times more profitable than maize for smallholder farmers (Zhou 2015).
[10] 45 days from planting date to maturity

extension and input supplies that match the needs of the farmers, and hence the relevance of its service is high.

b) Coherence

In terms of internal coherence, KHE is providing extension support for its outgrowers to help them adhere to national and international certifications such as Kenya-Good Agricultural Practices (GAP), Global GAP, Fairtrade, British Retail Consortium standards, and individual suppliers' standards. Most EU and UK food retailers require Global GAP certification, which addresses environmental impact, food safety, and worker welfare. To receive and maintain the certification, a farm must pass a quality management system audit, field inspections, and follow-up inspections, which can be difficult for smallholders to adhere to without access to technical knowledge of the standards.

KHE is also training its outgrowers to address the issue of maximum residue limits, which poses a severe threat to the industry. The intensified French bean production is affected by many pests and diseases such as leaf rust and wilting caused by fungus, and pests such as nematodes, negatively affecting yield, root nodulation and nitrogen fixing capabilities. To reduce the production cost, smallholder farmers resort to cheap, unsafe counterfeit phytosanitary products. The use of pesticides containing dimethoate is particularly problematic; while its maximum residue limit (MRL) for EU import was revised in 2009 and the Kenyan horticulture industry self-imposed a ban in 2012, inability to curb its use resulted in a 10% increase in physical checks of Kenyan fresh beans at ports of entry (USAID 2015). This caused the export of Kenyan French beans to the EU to decline by 18% in the first quarter of 2013. To

combat this issue, KHE trains its outgrowers on MRL and arranges access to recommended input supply. KHE has an incentive to provide these services, because the quality of produced goods made by the outgrowers directly affects their supply chain.

Regarding external coherence, KHE's extension service is consistent with the Government of Kenya's National Agricultural Sector Extension Policy (NASEP), which focuses on pluralistic and demand-driven extension services. The policy identifies two strategies for the extension services to focus on: "i) increasing productivity, commercialization, and competitiveness of agricultural commodities and enterprises; and ii) developing and managing the key factors of production" (NASEP 2012). The NASEP also recognizes extension services provided by the private sector to be crucial in commodity-based extension, stating its long-term goal as "to have private sector-led and fully commercialized extension service" (NASEP 2012). It can be said that KHE is already providing extension services that cover the two strategies in a manner that matches its long-term goal of private sector-led service.

Concerning the harmonization of services in the field, specific information regarding KHE could not be found in this research. However, there are examples of input sales representatives carrying out demonstrations in collaboration with the extension agents of the Ministry of Agriculture, as shown in the next case study. KHE may also have an opportunity to collaborate or coordinate with the public extension system to avoid duplication. In summary, KHE providing its outgrowers with extension services has high coherence with the adherence to food safety standards and the NASEP.

c) Effectiveness

Smallholder farmers that receive extension services of KHE have a strong incentive to adopt the instructed technique and technology because it will increase the likelihood of the sales of harvest. A time-bound contract with the KHE also adds to farmers' incentive to adopt its advice so that they can renew their contract next year.

On the other hand, KHE also has an incentive to provide an effective extension to reduce rejects and stabilize their supply chain. In fact, KHE has provided a range of extension services that meet smallholder farmers' needs: development of planting schedule, training in good agricultural practices, food safety and quality standards, monitoring of implementation through farm visits, and specifying products that match market requirements. In addition, KHE arranges access to input supply, purchases produced goods at agreed prices, and collects the harvest wherever possible. In some cases, KHE even provides seeds on credit and arranges loans from financial institutions to purchase other inputs such as approved crop protection products. This bundling of multiple services has successfully met a range of bottlenecks that previously prevented smallholder farmers from accessing the international market: lack of access to quality inputs, technical knowledge gap to meet productivity goals and obtain trade certifications, lack of reliable buyer of produce, etc. The transformation of the Kenyan horticulture sector from a fragmented predominantly smallholder farmers and small businesses to an increasingly vertically integrated model speaks to the effectiveness of the contract farming extension model.

However, the extent to which KHE can provide this range of services is limited to a handful of smallholder farmers. For example, in the case of loan arrangement for input purchase, KHE provides loan arrangements for input purchase to only 40% of its contract farmers which it regards as being loyal. Farmers who do not qualify for this credit arrangement service are expected to pay for inputs upfront in cash. This is because involving a third-party financial institution is risky, as farmers may sell their goods to companies other than KHE at harvest, breaching the contract after KHE investment has been made. Although regulated by the Order of 2011 by the Horticultural Crops Directorate, side-selling remains a common practice. The number of sponsored production schemes has declined in recent years because exporters are unable to recover the advanced input credit due to side-selling by farmers. The bundled services of the KHE extension are effective, but not all smallholder farmers can access every service.

d) Efficiency

The outgrower management model of KHE is efficient and well organized, and there is a clear division of responsibilities at multiple levels (Figure 3-1). The group agronomist is at the top of the outgrower management model, in charge of creating and revising the quality management system and maintaining relationships with local and international development organizations. The regional agronomists are responsible for implementing and supervising production in their designated regions. The quality management system representatives manage a limited number of groups, monitoring the adherence to the systems and providing technical support to the technical assistants. Technical assistants supervise planting, use of approved crop protection

products, fertilizer application, scouting, and record-keeping of farmers. The self-help groups provide funds for infrastructure, collection centers, and input procurement. Individual farmers oversee cultivation and harvesting. The KHE agronomists are responsible for providing inputs and technical assistance to farmers from several groups. The ratio of agronomists to farmers is about 1:200 (Zhou, 2015), a stark contrast against the figure for the public extension system, which is around 1:1000 (Hornum and Bolwig, 2021), even though the desired level indicated in the NASEP is 1:400 (NASEP, 2012).

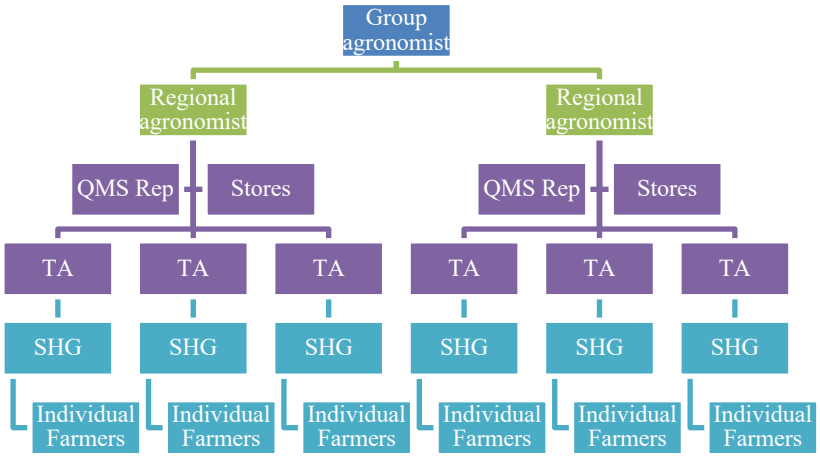

Figure 3-1: KHE Outgrower Management Model (Adapted from Zhou 2015)

From the farmers' perspective, the extension of KHE is efficient because the training and advice are specifically tailored to a particular crop they are growing. The system is also equitable, as self-help group farmers can freely decide whether to join the export activity or not. KHE does not select farmers within the self-help groups, and once the individual contract is signed, all outgrowers in the group would have access to the same services, regardless of gender, farm size, etc.

However, this efficient model does not work everywhere. The scalability of this model is limited, as it is not cost efficient to extend services in regions with less experience or soil suitability. In USAID-Kenya Horticultural Competitiveness Project (USAID-KHCP), farm-level recovery rates[11] of farms that traditionally cultivated French beans ranged from 69% to 100% in 2013, while newly established French beans farms ranged from 34% to 84%, due to poor crop management and harvesting skills, and inefficient collection systems of buyers (USAID 2015). Soil acidity and low levels of phosphorus due to the acidic parent material, nutrient leaching, and excessive weathering particularly in western Kenya is a challenge to productivity. While application of lime and Phosphorus is known to increase yield of French beans, cost effectiveness will become a major issue. In addition, the equitability of the system is also not universal, as there is bias against recruiting farmers with small total acreage. KHE needs to recruit geographically close farmers, each with at least half an acre of bean production, to ensure a minimum of one to two tons of goods per collection for an economical operation. Therefore, this extension model is efficient and equitable only for smallholder farmers that fit the KHE criteria.

e) Impact

The impact of KHE extension services goes beyond the increased productivity and quality of French bean exports supplied to KHE. Thanks to the training on food safety standards, smallholder farmers acquire new skills and knowledge to comply with the standards and provide accreditation details. By adhering to the standards, smallholder

[11] difference between total production and total sales expressed in percentage points

farmers improve their farm management skills and increase good agricultural practices. Farmers also gain awareness of the environment, leading to better waste management and pollution control.

While the impact generated by the KHE extension service is significant to those who could access the service, the scale of impact remains limited. The increasingly strict EU regulations for MRL have forced KHE to downsize its outgrower schemes supplying only 40% of its total production from outgrowers and sourcing the rest through its own farms to reduce the risk of contamination. The scalability of the extension model remains reliant on the international market conditions.

f) Sustainability

The sustainability of the KHE extension model is unclear, as it is highly dependent on product demand, requirements of the external market, and the domestic operating conditions, such as regulation on side-selling and the cost-benefit of production. Financially, the KHE extension services have proven to be sustainable so far, as the value added to the export crops has been covering the extension cost. However, this cost-recovery model for extension services is under threat. While the prices offered by the importers remained unchanged as KHE outgrower schemes grew in size, farm production costs increased due to the initial investment cost in expanding to inexperienced regions. Moreover, due to strict EU regulations, KHE has reduced its portion of outgrower production, as mentioned in e) Impact. The interconnectedness to the external market is both an advantage and a disadvantage of the KHE extension model.

Nevertheless, there is still hope in KHE's extension model as the local markets present a significant opportunity. As Kenya develops and the population's income rises, local supermarkets have pursued market segmentation around higher quality standards and organic produce. Although French beans were originally cultivated exclusively for export, they have become popular in the local Kenyan market. If the business continues to expand, there would be a need for the outgrower schemes to be scaled up, and hence there would be a business case for the extension services to continue. Even without business expansion, KHE is unlikely to completely phase out the outgrower schemes because most export companies work with both large farms and smallholders for risk management on supply. Moreover, the trust cultivated with outgrowers is a significant asset that KHE is unlikely to do away for short term gains. KHE rewards long-term outgrowers who have acquired technical skills and remained loyal to not side-sell by offering them credits. The long-term relationship with outgrowers built on trust is a win-win for KHE and smallholder farmers and increases the sustainability of KHE's extension services.

(3) Case 2: Irrigation Technology Suppliers in Kenya

Irrigation technology suppliers (ITS)[12] are defined here as firms that sell and/or produce irrigation equipment as a business. Hornum and Bolwig (2021) identified 19 ITS operating in Kenya in 2020, consisting of large and SME irrigation retailers or wholesalers, and equipment manufacturers. For example, there are agricultural inputs and/or equipment traders such as Amiran and Elgon Kenya, pump traders such as

[12] This excludes consulting and engineering firms that do not produce or sell the irrigation hardware.

Davis & Shirtliff, pipe manufacturers such as Agro Irrigation, and agricultural equipment producers such as Shade Net. Most manufacturers also retail their products, and several large trading companies conduct both retail and wholesale. Products include drip and sprinkler irrigation, water pumps (solar, fuel, grid-powered), water tanks and dam-liners for water storage and harvesting. The firms provide various services in relation to their products, such as provision of advisory, introduction and adaptation of new technology, and facilitation of access to finance. In this case study, the objective of the intervention is to increase smallholder adoption of irrigation technology, and the primary beneficiary is defined as the smallholder farmers, although the customers of ITS include large-scale commercial farmers.

a) Relevance

Smallholder farmers' adoption of irrigation technology is slowly increasing in Kenya. In 1990, the share of arable land equipped with irrigation was 1.08%, by 2000 it reached 1.74%, and in 2019 it accounted for 2.60% (FAO, 2022). This growth is attributed to the expansion of community-based irrigation schemes, which now account for about half of the irrigated area in Kenya (MWSI, 2019). The expansion of small-scale irrigation has created a market for technical services, as irrigation technology is not a 'plug-and-play' solution; it requires individual fitting to adapt the technology to the contextual factors of the particular farm and crop, and farmer training for correct operation and maintenance. All 19 of the ITS Hornum and Bolwig identified had in-house technical experts that provided consultation services to individual customers. As the public extension service lack the manpower as discussed in Case Study 1 and the technical capacity to perform the above service but also

simple repairs or solving common problems such as blockages or pipes clogging up, ITS extension model has high relevance to smallholder farmers' needs.

b) Coherence

In terms of internal coherence, ITS are pursuing technical service provision as product differentiation strategy to compete for market share. ITS are not only competing against each other, but also against the growing number of general hardware stores that sell irrigation equipment. For example, Amiran, a large wholesaler/retailer headquartered in London, sells drip irrigation equipment with installation service, training and an agro-support package in drip irrigation best practices.

In terms of external coherence, Government of Kenya has placed high policy priority on the promotion of irrigation. In Kenya Vision 2030 (GoK 2008), one of the strategies for agricultural development is expanding irrigated area especially in the Arid and Semi-Arid areas in Turkana and Tana Delta. In Big4Agenda (GoK 2017) under the food security and nutrition pillar, there is a target for a 700,000 acre (283,280 ha) increase in production of staple crop, which is to be grown under irrigation. In Agricultural Sector Transformation and Growth Strategy (MALFI 2019), actions proposed towards the goal to increase agricultural production from small-scale farmers include improving access to irrigation technology providers, promoting new irrigation technologies, increasing water storage capacity through dam construction, and providing subsidies for small-scale pump systems. Government of Kenya has also placed tax exemption for import duty and value-added tax (VAT) on irrigation

equipment.[13] Therefore, extension service provided by ITS is coherent with the policy priorities of the Government of Kenya.

There are many examples of harmonization between the public sector and ITS. Firstly, ITS often disseminate knowledge through public irrigation projects and field days, where an agent from ITS would oversee the demonstration component. For example, Irrico international, a large wholesaler/retailer, partnered with the Ministry of Agriculture, Livestock, Fisheries and Co-operatives (MALFC) in greenhouse demonstrations, where its staff trained farmers in the use of drip irrigation installed in the greenhouses. Greenserve Agrisolutions, a youth SME wholesaler/retailer, participates in trade fairs organized by the Kenya Livestock Producers Association (KLPA) and Irrico International in field days organized by MALFC every second month. ITS also signs MoUs with NGOs not only to provide technologies but also to disseminate knowledge, such as trainings to use drip kits and polytunnels, as part of different projects. These partnerships are crucial to the business model of many ITS, especially for companies that have the capacity to deal with large orders, because sales to irrigation projects through framework contract agreements are an important share of their total sales. Secondly, some leading ITS also engage with public research organisations, namely the Kenya Agricultural and Livestock Research Organization (KALRO), to develop and conduct trials for technical solutions adapted to a Kenyan context. It can be said that the extension model of ITS is intrinsically linked to the

[13] However, there are criticisms in the field regarding the lack of clarity of import regulations for spare parts and new equipment (Hornum 2020).

public sector, as the public sector created the market demand by developing irrigation schemes, and private sector supplied the technical expertise to operationalize them.

c) Effectiveness

Smallholder farmers face many difficulties in adopting irrigation technology:

i) financial constraints, such as lack of access to credit to cover the equipment and installation costs,

ii) inadequate irrigation technology, such as fragmented irrigation system that limits access to irrigation water or technology that is not adapted to local conditions such as natural water scarcities,

iii) poor supply chain for irrigation technology, such as lack of local offices or availability of spare parts, limiting access to affordable and/or appropriate technology,

iv) unmet technical capacity needs for irrigation technology, as public extension system in Kenya lacks the capacity to teach, demonstrate, and raise awareness of irrigation technologies, and

v) uncertain agricultural market conditions, which increases the risks of investing in irrigation technology.

However, these constraints are addressed by the different services ITS offer (see Table 3-2 for details).

Table 3-2: Constraints of Smallholder Farmers Addressed by ITS to Encourage Access to Irrigation Technology

Constraints faced by smallholders	Service provided by ITS	Examples
i) Financial constraints	Provision of financial service	> Arrangement of loan through financial institutions (e.g. payback arrangements with risk assessment) > Lease-to-own finance > Pay-as-you-go finance (e.g. SunCulture and FuturePump)
ii) Inadequate irrigation technology	Design and installation of irrigation equipment	> Customization of irrigation solutions to fit the needs of clients > Installation of irrigation equipment
iii) Poor supply chain	Operation and maintenance of irrigation	> After-sale maintenance
iv) Unmet technical capacity needs	Training and demonstrations in irrigation systems	> Training in irrigation practices (e.g., operation and maintenance of equipment) > Operation of demonstration sites > Participation in agro-fairs
v) Uncertain agricultural market conditions	Provide market information and assist in marketing of outputs and inputs	> Advise on available market options > Link farmers to buyers (wholesalers and exporters)
	Provide agri-inputs and training in crop management	> Provide farmers with agricultural inputs (e.g., fertilizer and seeds) > Training in optimal application with irrigation system (e.g. fertigation and crop management)
	Guidance in farm management	> Assistance in developing production and business plans

(Adapted from Hornum and Bolwig 2020)

Bundling of service with financial products has been particularly innovative. ITS has various service models, including direct finance through partnership with a financial institution, a lease-to-own model in which farmers make payments in instalments and own the equipment after full payment, and a pay-as-you-go model, in which farmers make payments on a per-use basis. Direct finance is provided mostly by large companies such as Irrico International, Davis and Shirtliff, Amiran and G. North and Sons, that partner with commercial banks. The pay-as-you-go model

offered by SunCulture and Futurepump is enabled by Kenya's well-developed mobile network coverage; the solar-powered water pumps are linked to meters, allowing smallholder farmers to make small payments on a per-usage basis.

However, scalability remains an issue in these finance models, because there is a trade-off between the risk of loan default by farmers and increase of smallholder customers. For example, Davis and Shirtliff does not offer payback arrangements, as it regards the risk of default to be too high. Instead, it offers a loan product for its solar pumps, in which the company creates a business plan with the farmer, who then takes the plan to the partnering Equity Bank for credit. Irrico International has an MoU with KCB bank for a buy-back guarantee of its greenhouse system, in which Irrico International buys back the equipment at a reduced price in cases of default, to help the farmer pay back the loan, mitigating the investment risk.

Regarding the quality of the service provision, more research maybe necessary. While Hornum and Bolwig (2020, 2021) argue that the larger companies have shown high standards of technical expertise, evidenced by their ability to cater to government and donor-funded projects, other research (Garb and Friedlander, 2014) has raised concerns about the lack of capacity and the motivation of input suppliers to deliver information to farmers.

d) Efficiency

ITS has made human resources available to support farmers adopt irrigation technologies. Especially when large companies such as Amiran, Irrico, Davis and Shirtliff, G. North and Son receive contracts under government or donor-funded

projects, many employ technical experts at local branches to deliver support services. Alternatively, Greenserve Agrisolutions have opted to use external rural agents to perform this function. As a direct link between farmers and technologies, ITS also have the ability to influence resource mobilization. Through partnerships with foreign irrigation manufacturers, ITS have brought foreign know-how and premium irrigation equipment to the Kenyan market. ITS is instrumental in increasing the volume and variety of technology available in the market.

However, scaling of this model has been limited, as ITS service provision remains largely confined to commercially oriented smallholders and customers with other sources of income, who are willing and able to afford the services. Although ITS have been able to reach many smallholder farmers through contacts under public projects, the provision of service to individual non-commercialized small-scale farmers are limited, due to their small purchasing power. Even with the provision of financial services, many smallholders still cannot afford the technology. Moreover, ITS presence remains geographically confined to major cities and high-potential area. While ITS activities have promoted diffusion of irrigation technology in Kenya, support from donors, finance institutions and government may still be necessary to close the affordability gap. It is important to note that the entry of private sector did not occur in Kenya until the market for irrigation equipment and service had grown to a sufficient size in the early 2000s, thanks to the development of irrigation schemes over the years by the government and donors. Therefore, application of the ITS extension model to

other countries should be made keeping in mind that it must be accompanied with a long-term public investment.

e) Impact

One positive impact of ITS service provision is the development of legitimacy to the irrigation technology. As discussed in b) Coherence, some ITS engage in research through partnerships with public research institutions and organizations. They also advocate the benefits of irrigation equipment through various marketing strategies including TV and social media advertisements, demonstrations at field days, and stories of successful adoptions. This shaped positive expectation and led to greater social acceptance of new irrigation technologies. As ITS grew in numbers and sales volumes, their influence on expectation for modern irrigation technologies increased through their exchanges with policymakers and farmers. With these connections, ITS is able to fulfil the role not only of knowledge and equipment dissemination, but also demand articulation for farmers and network-building.

ITS has also positively impacted product innovation and adaptation. Low-cost solar PV pumps produced by SunCulture, FuturePumps and KickStart are a good example for product innovation. ITS have also contributed to adaptation of imported irrigation systems to the local context by testing, through transnational knowledge transfer such as giving feedback and providing data to foreign equipment manufacturers that are trying to introduce and adapt their products to the Kenyan market.

f) Sustainability

While the emerging innovation in financial products is promising, the sustainability of business model targeting smallholder farmers remain uncertain. In general, ITS business models can be categorized in to three types: direct sales to individual farmers without financing, direct sales to individual farmers with financing, and sales to irrigation schemes. Although direct sales business model without financing service exists, majority of customers for this model are not smallholder farmers, as the initial cost is too high especially for the bottom segment of the smallholder farmers. While some irrigation companies such as Davis and Shirtliff and G. North and Son claim that the majority of their sales to the smallholder farmers consist of direct sales to individual farmers, these purchases are typically made by part-time farmers who have other sources of income, and intend to invest in backyard gardening or urban/rural farming of inherited land.

Therefore, for ITS to reach the majority of smallholder farmers with irrigation technology directly, some form of financing is necessary. However, financing is risky both for the ITS and the farmers. ITS are sensitive to the high risk associated with financing for smallholder farmers as described in c) Effectiveness. Farmers often perceive loan products as unattractive and risky even when they are eligible, due to high interest rates, short grace periods, requirements for collateral, and the risk of failed harvests. Therefore, there is a continued need for innovation in minimizing costs to reduce risk and bridging the gap between the existing loan products and farmers' capital

needs, which could be supported by financial mechanisms such as revolving funds and credit guarantees from development institutions and government funding.

This suggests that the irrigation technology diffusion by ITS extension model still requires public intervention. This is partly because economies of scale only work in large irrigation schemes, as bundling extension support and financing services with technology delivery reduces profit margin especially in small-scale farms, due to increased personnel and transportation costs. As it had been in the past, the government and development agencies can continue to play the role of developing irrigation schemes, and the ITS can supply the equipment, personnel, and the knowledge to promote smallholder access to irrigation technology. However, Hornum and Bolwig (2021) found that some ITS saw decline in public investment in small-scale irrigation projects over the past two years. Moreover, frequent delay in payments for public contracts has become a concern, turning away some companies from pursuing tenders. As the scale of smallholder access to irrigation technology is limited in the direct sales business models, decline in business with irrigation schemes may have a negative effect on the rate of irrigation technology adoption by smallholder farmers. Therefore, it is important that the government continue to place high priority on irrigation policies to ensure that this business model remains attractive for the ITS.

IV. Conclusion

The private sector can meet the extension needs of smallholder farmers in developing countries by playing a complementary role to the public sector in the AIS,

especially in transferring excludable agrarian information, such as in the case of contract farming for high-value export crops and irrigation technologies.

In Case 1, KHE supplies a non-rivalrous yet excludable specialized agricultural information on farm management techniques to comply with international standards. Therefore, it is providing a "toll-good." KHE also facilitates access to a rivalrous and excludable modern technology of certified inputs, which is a "private good". Although this distinction limits KHE's outgrower base to those who have the financial capacity to access the excludable technology, for example, by forcing newly recruited farmers to pay for seeds in cash upfront, this lack of inclusivity is perhaps justified in terms of complementarity with the public extension system.

In Case 2, ITS supply excludable and rivalrous "private good" such as hardware and the practice of drip irrigation, as well as the non-excludable but rivalrous "common-pool" such as irrigation management training through government or donor contract in large irrigation schemes. Although there are some innovative financial products being bundled with the service provision, access to "private good" irrigation remains largely limited to farmers with the financial means. The provision of "common-pool" irrigation information has been dependent on government or donor projects. However, the collaboration with the government in the provision of "common pool" has caused market expansion for ITS, as more smallholder farmers (and government project managers) are interested in the technical expertise of ITS, allowing ITS to expand its business models to "private good" provision.

Therefore, as Umali and Schwartz (1994) argue, the public extension system should provide the non-excludable "public good" and "common-pool," and the private

extension services should provide the excludable "private good" and "toll-good." In a pluralistic extension system, it can be said that extension stops being a public good when the agricultural information being transferred are excludable.

However, a pure private sector extension without public support is impractical and undesirable. A pluralistic extension system must be established to meet the needs of all farmers. Then, what roles should the public and private sectors play? In Case 1, the private sector extension primarily serves commercial farmers who farm a high-value crop and leaves the public sector to serve the marginalized farmers. To recover the cost of intensive extension without a public sector support, the harvest must be sold at a high price. In this model, the success of the private sector extension is dependent on product demand, requirements of the external market, and the domestic operating conditions. The government should enact policies to eliminate bottlenecks for the private sector extension, such as increasing contract regulation to prevent side-selling, and putting in place an incentive system for providing information that contributes to social welfare. The government should coordinate different actors in extension to ensure the efficient functioning of the AIS.

Case 2 indicates a high potential of public-private collaboration. From the government's perspective, the national agricultural extension system can capitalize on the services offered by the ITS, as there is a clear need to train smallholder farmers and extension staff in modern irrigation technologies. From the ITS's perspective, partnerships with public and other private actors would allow them to co-develop, utilize, and disseminate knowledge effectively. They can also play a major role in transnational knowledge transfers. Therefore, ITS have considerable agency in relation to AIS, as

they bring expertise, investment and innovations in technology, service provision and business models. As this agency depends on the market size as indicated earlier, it is important that the government continues investment in irrigation alongside efforts by the ITS. These policies would enhance the private and public complementarity, and can improve the pluralistic extension system.

In the context of Kenya, the strength of private sector extension services lies in providing specialized agricultural information and access to excludable modern technologies by bundling multiple services and putting in place an intensive and efficient system. Although it lacks the inclusivity and the scale of the public extension system, private sector extension services should be regarded as the provider of "private good" and "toll-good," which complements the public extension system.

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CONCLUSIONS

This comparison of agricultural innovation systems (AIS) characteristics in Senegal and Kenya has revealed important similarities, differences, and instructive lessons. Both countries have benefited from increased government and donor investment in the agriculture sector, and greater recognition of the role that extension policy plays in the efficacy of national AIS. While Senegal's AIS is enhanced by strong producer organizations, Kenya's strength lies in the widespread access to and usage of ICTs. Both suffer from research-extension linkages and inadequate mechanisms for coordination in an increasingly pluralistic extension and advisory services "system".

The functionality assessment of Senegal revealed that the donor projects in the case study made impact to all six components of the function of AIS. However, it was unclear (and perhaps not visible or measurable) whether the projects advanced the capacity of the actors in the AIS to take charge of the function themselves, especially in the component of Guidance of Search and Entrepreneurial Activities and Experimentation. Perhaps this is an indication that more effective approaches to project monitoring and evaluation are long overdue. As the intended outcomes, approaches, network/collaboration processes, and prerequisite capacities for high impact agriculture and the extension and advisory systems shift over time, the way we evaluate these projects must adapt accordingly.

The case studies in Kenya revealed that the private sector actors can meet the extension needs of smallholder farmers by playing a complementary role to the public sector in the AIS, especially in transferring excludable agrarian information, often as a function integrated within vertical value chain alliances such as contract farming for high-value export crops and irrigation technologies. Sustaining inclusivity for smallholders in such arrangements over the longer term remains an area of potential concern. For Kenya, the strength of private sector extension services lies in providing specialized agricultural information and access to excludable modern technologies by bundling multiple services and putting in place an intensive and efficient system. Although it lacks the inclusivity and the scale of the public extension system, private sector extension services should be regarded as the provider of "private good" and "toll-good," which complements the public extension system.

High-functioning AIS is key to tackling the mounting challenges of food insecurity and climate resilience in agriculture. With the rise of private extension and advisory services, the task of public extension agents has shifted from a linear transfer of technology to demand articulation and stimulation, network and knowledge brokering, capacity and institutional building, and innovation process management. Although insufficient funds, mismatch of skills, and institutional barriers have been preventing them from achieving their full potential as an innovation intermediary, effective policy can play a key role in embracing the plurality and creating an enabling environment for innovation processes to take place.