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Guide for monitoring and evaluation of the public agricultural extension and advisory service system

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by

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Summary

The public agricultural extension and advisory service (EAS) system plays a critical role in achieving national food security, improving rural livelihoods, and strengthening natural resource management. When operating in an effective and efficient way, the public EAS system facilitates and mainstreams innovation for transformative agricultural development towards sustainability. To strengthen this role, adequate and impactful investment and enabling policies that are evidence-informed must be secured so as to build an effective and efficient public EAS system. Therefore, the performance of the public EAS system, the cornerstone of the national EAS system for agricultural development in developing countries despite the trend of pluralism, needs to be regularly and properly evaluated. This is aligned with the request made by the 27th Session of the Committee on Agriculture (COAG 27) of the Council of the Food and Agriculture Organization of the United Nations (FAO). The FAO was requested to strengthen its strategic guidance and technical support for Members in two major areas: On the one hand, to promote institutional reforms, EAS reorientation, and development of technical and functional capacities of their public EAS system; and on the other hand, to generate evidence for informed policy and investment decisions.

Under this context, the FAO needs to play a greater role in assisting Members in developing an effective M&E system of public EAS. In response, the FAO, through its Office of Innovation (OIN), has developed this guide. It highlights the importance of the public EAS system's self-monitoring and self-evaluation (self-M&E) which are critical to its healthy development, functionality, sustainability, and service quality. The guide introduces a systemic, holistic and easy-to-use methodology that is multiscalar, multisectoral, and multidimensional for the self-M&E of the public EAS system. An effective application of this methodology is expected to help identify the gaps and loopholes in the existing public EAS system. This will be useful for identifying entry points for strengthening and reforming EAS systems and supporting evidence-informed policymaking and investment decisions. In doing so, it will serve as a robust tool for embarking on and shaping the pathway of the public EAS system reform.

The guide is organized as follows: Part 1 provides a brief introduction to the background, rationale, and structure of this guide. Part 2 carries out a critical review of M&E systems, focusing on their objectives, institutional setting, types and methods, challenges and lessons learned. Part 3 expounds on the logic framework of the proposed M&E framework. Part 4 explains the rationale and objectives of monitoring and evaluating the public EAS system from the perspectives of different stakeholders. Parts 5 and 6 respectively present the M&E modules at the national and grassroots levels, following such an order as introduction, key M&E elements, indicator framework, and operational framework. Regarding the indicator frameworks, Part 5 proposes national-

level indicators categorized according to the structure, functions, capacities, enabling environment, and key outputs and outcomes in terms of accountability, accessibility, affordability, adaptability and achievements of the public EAS system. Part 6 proposes, instead, grassroots-level indicators classified into inputs, activities, outputs, and outcomes following the order of the theory of change of EAS delivery. Part 7 looks at the issues of data sources and data collection. Part 8 discusses the issues related to capacity building, focusing on the institutionalization of the self-M&E system in the public EAS system and training of public EAS agents on its self-M&E. Part 9 introduces the commonly used tools and methods of data analysis.

The state-of-the-art of this guide lies in that it is the first of its type to adopt a multisectoral, multidimensional and multiscalar approach to the M&E of the public EAS system. The proposed indicator frameworks allow for a systemic and holistic diagnosis of the public EAS system at the national and grassroots levels. Therefore, it can help competent public authorities gain more comprehensive, accurate and meaningful information on the performance of the public EAS system. It can be adapted according to local contexts and used by competent public authorities and EAS agencies as a self-M&E tool. It can equally be useful for donors, research institutes, academia and so on. In addition, it can also be adapted to and integrated into training of trainers (ToT) courses, e-learning courses and other practical training on the M&E of the public EAS system.

Contents

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Abbreviations and acronyms

AIS	agricultural innovation system
ATI	Filipino Agricultural Training Institute
COAG	Committee on Agriculture
COVID-19	coronavirus disease 2019
DAE	Department of Agricultural Extension
DFID	Department for International Development
DPSE	Planning and Monitoring and Evaluation Department (French: La Direction de la Planification et du Suivi Evaluation)
EAS	extension and advisory services
FAO	Food and Agriculture Organization of the United Nations
FFS	farmer field school
FGD	focus group discussion
GDP	gross domestic product
GFRAS	Global Forum for Rural Advisory Services
GIS	geographic information system
ICT	information and communication technology
IFPRI	International Food Policy Research Institute
ISS	innovation support services
IT	information technology
M&E	monitoring and evaluation
MAEP	Ministry of Agriculture, Livestock and Fisheries of Madagascar (French: Ministère de l'Agriculture, de l'Elevage et de la Pêche)
NAADS	Ugandan Secretariat of the National Agriculture Advisory Services
NGO	non-governmental organization
OECD	Organisation for Economic Co-operation and Development
OIN	Office of Innovation
Self-M&E	self-monitoring and self-evaluation
TAP	Tropical Agriculture Platform
ToC	theory of change
ToR	terms of references
ToT	training of trainers
UNODC	United Nations Office on Drugs and Crime
USAID	United States Agency for International Development

1. Introduction

Public agricultural extension and advisory services (EAS), normally provided by public agencies free of charge, are all the different activities that provide the information and services needed and requested by farmers and other actors in agriculture. These activities are aimed to assist them in developing their own technical, organizational and managerial skills and practices to improve their livelihoods, income and well-being while promoting sustainable agriculture. By facilitating and mainstreaming innovation for transformative agricultural development towards sustainability, the public EAS system plays a critical role in achieving national goals such as strengthening food security, improving rural livelihoods, and enhancing natural resource management. It is of vital importance for smallholder farmers in particular who depend on them for accessing agricultural techniques, knowledge on health, nutrition and agroecology, digital literacy and so on. Therefore, without an efficient public EAS system, the "four betters (better production, better nutrition, a better environment and a better life)" as the FAO advocates will be barely achievable.

When public EAS systems were established in most developing countries during the twentieth century, most were organized under ministries of agriculture. As a result, the majority of these agencies became top-down, multifunctional, and resource-constrained systems that lacked adequate operational resources as well as competent technical specialists (Swanson and Rajalahti, 2010). Since the 1990s, countries worldwide have adopted various initiatives to reform their public EAS system that were either market-oriented or non-market-oriented. These reforms generally have followed three models, including (1) decentralization of services; (2) outsourcing of services to private, either not-for-profit or commercial organizations; and (3) (partial) privatization of services (Bitzer *et al*., 2016). Following these reforms, most of countries currently have a national EAS system that is

decentralized and pluralistic, in which the public sector can be weak and inadequate in some. However, today, understaffing, non-adherence to set rules and procedures, lack of funds, lack of coherence, and siloed approach, just to name a few, are among the main challenges faced by the public EAS system at the subnational levels (Buyinza *et al*., 2015; Davis *et al*., 2020). These major challenges have prevented the public EAS system from contributing to the above-mentioned goals. Meanwhile, broadened EAS scope, governance failures, growing system complexity, increasing pluralism, and need for resilience of agrifood systems, are becoming drivers of multifaceted change of agricultural EAS systems worldwide.

Indeed, EAS systems have to continuously change to respond to broadening EAS scope, governance failures, growing system complexity, increasing pluralism, and need for resilience of agrifood systems while improving their performance. According to Feder and others (2001), the scale, scope, and complexity of EAS activities determined by the nature of agricultural production and the associated issues of monitoring, evaluation and learning to establish feedback linkages are key factors that affect the performance of agricultural EAS systems. To foster EAS systems' ability to continuously change and improve their performance, monitoring and evaluation (M&E) systems that are well designed and implemented, in close consultation with the intended users, are a powerful tool (Wongtschowski *et al*., 2016). The efficiency, effectiveness and relevance of the public EAS system can be substantially enhanced if it engages in systematic self-evaluations of its performance (Grovermann *et al*., 2022). Rigorous assessments and evaluations will strengthen the case for further investments in EAS as well as identify systems in need of reform and effective management (Davis *et al*., 2020). The trade-off between the quantity and quality of EAS professionals can be addressed only through feedback provided by a well capacitated M&E system (ibid.). Besides, M&E are intrinsically linked to accountability and the quality assurance of services (Blum *et al*., 2020), playing a crucial role in contributing to (European Commission, 2017):

- timely and relevant advice to decision-making and providing inputs to political priority-setting;
- organizational learning: Evaluation results can be used to improve the quality of an ongoing intervention and in the development, implementation and design of policies. Moreover, they can identify opportunities for simplification and reduction of regulatory burdens for future policies;
- improving the legitimacy, transparency, accountability and demonstrating the added value of public EAS; and
- a more efficient allocation of resources between interventions, between the separate elements of a specific programme or activity, or between

activities. M&E results are key instruments to inform evidence-based decisions on cost-effective public spending.

The changing nature and current status of EAS have contributed to difficulties in evaluating EAS systems at the national level (Davis *et al*., 2020). Worldwide, EAS systems today are seeing the trend of pluralism and privatization, making it difficult to define and measure service outcomes and impacts (ibid.). Despite the trend of pluralism and privatization, the public EAS system should still remain the cornerstone of the national EAS system for agricultural development in developing countries. To better underpin national agricultural development, the public EAS system must effectively address the above-mentioned challenges that it faces. Therefore, rigorous M&E are needed to help improve its performance. However, poor operation of planned M&E systems, lack of appropriate performance indicators, inadequate focus on EAS users, and over-ambitious or unworkable methodologies, or even not undertaking any M&E at all are common weaknesses in M&E systems at present (FAO, 2010). Such weaknesses exist irrespective of the country, type or size of the EAS project, whether it was implemented during the 1990s or more recently (ibid.).

In fact, a variety of problems prevent M&E from generating expected benefits for making public EAS system more efficient and responsive to change. First, public EAS agencies tend to lack the capacity to plan and conduct systematic self-M&E, while national policymakers and programme managers lack understanding of the theory and practice of EAS programme development and evaluation (Suvedi, 2011). Second, there are also conflicting reports on extension performance, as the overwhelming majority of evaluation reports claim positive extension outcomes are not in line with the reports on agricultural productivity growth in the region (Taye, 2013). There are various reasons for over-estimated effectiveness and contradictory results, which include use of poor evaluation methodologies, lack of reliable data and insufficient capacity to conduct rigorous M&E (ibid.). Third, public EAS agencies have not been able to make full use of M&E data for specific programme improvement and personnel management purposes (Suvedi and Stoep, 2016).

A major gap in the EAS literature is the lack of common framework and comparison of M&E of national or regional EAS systems (Davis *et al*., 2020). There is also a lack of research that evaluates EAS from a systemic perspective and combines qualitative and quantitative methods (Faure *et al*., 2016). Past mistakes will be repeated if there is no greater awareness of what of the public EAS system has worked and what has not, what has proven sustainable and what has not, and who has accessed and benefited from public EAS and who has not (Davis and Heemskerk, 2012). In response to the need of a more effective M&E methodology to enhance the efficiency and effectiveness of the public EAS system, this guide provides a

holistic and systematic methodology that is multiscalar, multisectoral, and multidimensional for monitoring and evaluating the public EAS system. It is organized as follows: Part 1 provides a brief introduction to the background, rationale, and structure of this guide. Part 2 carries out a critical review of M&E systems, focusing on their objectives, institutional setting, types and methods, challenges and lessons learned. Part 3 expounds on the logic framework of the proposed M&E framework. Part 4 explains the rationale and objectives of monitoring and evaluating the public EAS system from the perspectives of (1) policymakers and investment decision-makers at the national (macro) level; (2) public EAS agents at the grassroots (micro) level; and (3) public EAS beneficiaries including smallholder farmers at the grassroots level. Parts 5 and 6 respectively present the M&E modules at the national and grassroots levels, following such an order as introduction, key M&E elements, indicator framework, and operational framework. Regarding the indicator frameworks, Part 5 proposes national-level indicators categorized according to the structure, functions, capacities, enabling environment, and key outputs and outcomes in terms of accountability, accessibility, affordability, adaptability and achievements of the public EAS system. Part 6 proposes, instead, grassroots-level indicators classified into inputs, activities, outputs, and outcomes following the order of the theory of change[1] (ToC) of EAS delivery. The indicators were selected in reference to the FAO publication Guide for monitoring and evaluation of the public agricultural extension and advisory service system (https://doi.org/10.4060/cc2131en) and also to the results from EAS experts discussions during the FAO's international workshop on "Global Review and Assessment of Public Agricultural Extension and Advisory Service Systems" held in 23–24 February 2022. Part 7 looks at the issues of data sources and data collection. Part 8 discusses the issues related to capacity building, focusing on the institutionalization of the self-M&E system in the public EAS system and training of public EAS agents on its self-M&E. Part 9 introduces the commonly used tools and methods of data analysis. It presents the weighting of indicators, scoring method, and integrated multidimensional and multiscalar M&E analytical frameworks.

This guide is an innovative tool which competent authorities at different administrative levels can adapt according to local context and deploy to monitor and evaluate the public EAS system. Its state-of-the-art consists in its "systems thinking" and featuring a multisectoral, multidimensional, and multiscalar M&E methodology. First, it proposes systemic, holistic indicator frameworks that cover the principal agricultural sectors, including agronomy, animal husbandry, aquaculture, and agromachinery. Second, the indicator frameworks also allow a multidimensional diagnosis of the public EAS system in terms of institutional, mandates, human resources, financial,

[1] "Theory of change" defines long-term goals and then maps backward to identify necessary preconditions, tracing therefore the process of change by outlining causal linkages in an activity (van Mierlo, 2011).

infrastructural, and enabling policies. Third, the indicator frameworks combine the M&E activities at both national and grassroots levels, enabling a more scalar understanding of the functionality of the public EAS system. Fourth, the guide also provides integrated M&E analytical frameworks for comparing different EAS systems, analysing constraints, identifying existing gaps, and developing action plans for strengthening the public EAS system.

At the national level, this guide is useful for policymakers and investment decision-makers for making evidence-informed policies aimed at strengthening the public EAS system. At the grassroots level, it supports local public EAS agencies or agents to identify gaps and capacity needs in service delivery to improve service quality and increase impact. Besides, it is a useful tool for facilitating smallholder farmers or farmer organizations to feedback their needs to help improve and strengthen the public EAS system. It can equally be useful for donors, research institutes, academia and so on. In addition, it can also be adapted to and integrated into training of trainers (ToT) courses, e-learning courses and other practical training on the M&E of the public EAS system.

2. Monitoring and evaluation of extension and advisory service systems: A critical review

2.1 Objectives

M&E are a process of continual gathering and assessment of information in order to (1) determine whether progress has been made towards pre-specified goals and objectives of EAS, (2) provide information for decision-making on any improvements needed for management and implementation, (3) serve as a means to empower the EAS communities and other stakeholders for sustainable agricultural development, and (4) highlight whether there are any unintended (positive or negative) effects from EAS (UNODC, 2002). While monitoring is generally concerned with regular collection and analysis of information to assist timely decision-making at various steps in the process of an initiative or project and ensure accountability, evaluation deals with the systematic assessment of achievement of EAS objectives, efficiency and impacts (Lai, 2012).

An effective M&E system should at a minimum be capable of the following: (1) supporting results assessment and its use for decision-making; (2) providing timely information to meet operational as well as strategic management requirements; (3) triggering learning and adaptation; and (4) eliciting participation and buy-in among key stakeholders (ibid.). To assure this capability, a clear definition of EAS M&E objectives is a precondition as it is important for deciding which methods are to be used (van Mierlo, 2011). EAS M&E generally have two objectives of accountability and learning, which ideally should be complementary (Wongtschowski *et al*., 2016). On the one hand, M&E on the accountability of EAS commonly focus on upward accountability to government or the funding agency. EAS M&E are often an obligation to demonstrate that contracted work has been conducted in compliance with agreed standards or to report on results vis-à-vis plans. On the other hand, EAS M&E for learning require continuous

and conscious involvement of evaluators and stakeholders in collaborative learning, allowing key stakeholders to share their views, perspectives and ideas, without fear of negative consequences (Kusters *et al*., 2011 cit in Wongtschowski *et al*., 2016). Given the increasing demand for development accountability and impact, the limitations of quantitative indicators following the results-oriented EAS M&E paradigm, and the value of understanding the underlying knowledge and learning processes, there is a call for learning-oriented EAS M&E paradigm (Woodhill, 2007 cit in FAO, 2010). Therefore, the objectives of M&E of EAS systems should be a balance between (1) addressing accountability issues by providing evidence to policymakers or donors or main clients to make decision about investments, and (2) the use of learning processes to build a shared diagnosis among key stakeholders and help them to improve EAS (Faure *et al*., 2016). Besides, the need for demand-driven approaches to EAS provision requires that M&E pay more attention to the downward accountability, namely, to EAS users, especially smallholder farmers.

2.2 Institutional setting

It is essential that the national and the state-level extension departments develop and implement a comprehensive monitoring, evaluation and learning system for all the processes, actions, and outputs involved in the various segments of the agricultural EAS system (Davis *et al*., 2020). In many countries, there is a general M&E unit within the ministry of agriculture or directorate of agricultural EAS that is in charge of the M&E of the public EAS system. This unit gathers periodic data on several general output variables, including number of female and male participants, types of extension activities implemented, crop and livestock activities and conditions, market information, and ongoing and emerging educational needs of their clientele (Suvedi and Stoep, 2016). Often times, such a unit exists at the national level, while at the subnational levels, especially at the grassroots level, there may be poor institutional arrangement for M&E activities and related coordination and reporting.

In Viet Nam, the National Agricultural Extension Center (NAEC) plays the role of monitoring, evaluation, and communication (Ngan and Babu, 2018). In Japan, M&E is in the charge of the Evaluation Office of the Coordination and Administrative Inspection Division under the Secretariat of the Ministry of Agriculture, Forestry and Fisheries. In Uganda, the Secretariat of the National Agriculture Advisory Services (NAADS) has a Planning, Monitoring and Evaluation Department. In the Philippines, the Agricultural Training Institute (ATI) of the Department of Agriculture (DA), in operation since 1987 has a Planning, Monitoring and Evaluation Unit which monitors and evaluates the implementation of the ATI's plans and programmes through

performance reviews, technical guidance sessions, and results evaluation studies. In Algeria, M&E of EAS activities are undertaken by the National Institute of Agricultural Extension (INVA), an administrative public entity established in 1995 and focal point for the Ministry of Agriculture and Rural Development which supports the current agricultural and rural development policy in collaboration with the agricultural professionals.

In Madagascar, EAS M&E are conducted at three levels, each of which has a different institutional arrangement for M&E activities. At the national level, there is the Planning and Monitoring and Evaluation Department (DPSE - Direction de la Planification et du Suivi Evaluation) under the Coordination and Support Unit for Projects and Regional Activities (CPAR - Cellule de Coordination et d'appui aux Projets et aux Activités Régionales) of the Ministry of Agriculture, Livestock and Fisheries (MAEP - Ministère l'Agriculture, de l'Elevage et de la Pêche). The DPSE performs the following duties: (1) the Planning and Monitoring and Evaluation Service (SPSE); (2) the Support and Monitoring Service for Projects and Related Bodies (SASPO); and (3) the Regional Activities Support and Monitoring Service (SASAR). At the regional level, the Regional Directorates of Agriculture, Livestock and Fisheries (DRAEP) offer the Regional Service for the Information and Monitoring and Evaluation System (SRSISE). At the level of the Headquarters of Districts (with the exception of the Districts of the Regional Headquarters), an Agriculture, Livestock and Fisheries Circumscription (CIRAEP) will be set up according to the priorities. It coordinates the work of the Agricultural Technician Advisers who provide supervision and technical support to professional organizations and producers as well as monitoring the implementation of the Ministry's activities at the local level. In Belize, the Ministry of Agriculture, Food Security and Enterprises established an M&E Unit in 2012 with the onset of the Ministry moving from line budgeting to programme budgeting. The latter focuses on results-based planning that requires reporting on outputs achieved with the resources invested, the outcome and impact that these will have on the livelihoods of farmers. The Unit collaborates with the Ministry of Agriculture Project Execution, the Ministry of Economic Development, and the Ministry of Finance and Partners in Development.

2.3 Types and methods

In terms of the stages in which M&E activities are undertaken, there are four major evaluation types, namely (1) the inception evaluation, (2) the interim or mid-term evaluation, (3) terminal or completion evaluation, and (4) post-project or impact evaluation (UNODC, 2002) (Table 1). Similarly, Horton and Mackay (2003 cit in DFID, 2010) categorize evaluation methods into two major categories. The first four types of evaluation (needs assessment,

priority setting, evaluation of research proposals, and monitoring of ongoing research) identified in the framework are generally carried out to support internal decision-making. The second four types – evaluation of completed projects, evaluation of research outputs, impact assessment and programme reviews – are typically conducted to meet external accountability requirements. In terms of the subject who undertake M&E activities, EAS M&E are carried out in two main ways (Karasartov *et al*., 2015). Firstly, *external EAS M&E*, wherein the M&E of EAS are carried out by independent experts who are hired by financing organizations or professional M&E specialists of these organizations. M&E of EAS are usually carried out at the end of each year or every six months. Secondly, *internal M&E*, wherein necessary M&E of EAS activities are constantly undertaken by agents of the public EAS system in order to determine whether the planned work is going in the right direction or not. On the basis of these activities, the organization continues improving the quality of the services provided.

TABLE 1. **Common monitoring and evaluation tools and techniques**

Programme stage	Types	Typical questions	Examples of M&E tools and techniques
Planning stage	- Needs assessment - Feasibility study - Baseline study	What are the felt and unfelt needs of the audience? Can extension address these needs? Do they fit with extension's mission? Is the programme or project socially, economically, environmentally feasible?	Surveys; Focus Groups; Observation; Content Analysis (e.g. of office records); Economic Analysis (e.g. benefit/cost analysis)
Implementation stage	- Formative evaluation - Programme monitoring	Is the programme meeting its objectives of intended outcomes? Are the audience satisfied with the programme? Are the media delivering programme messages?	Annual Monitoring Reports (e.g. staff time and activity reports, crop yield, seed cost); Adoption Patterns for New Technology; Evaluative Studies of Knowledge, Attitude, and Behaviour Change; Customer Satisfaction Surveys; Content Analysis of News Releases
Concluding or results stage	- Impact assessment - Summative evaluation	Has the programme addressed the needs or gaps identified? Is the programme achieving desired outcomes? Is the programme cost-effective?	Pre- and Post-project Data Analysis; Cohort Studies; Panel Studies; Surveys (e.g. personal interviews, telephone surveys, mail surveys, online surveys); Economic Analysis

Source: **Suvedi, M. & Stoep, G.V.** 2016. *Improving the monitoring and evaluation of agricultural extension programmes.* Michigan, Michigan State University.

In general, the performance of EAS system or programme and EAS providers are measured against such aspects as farmer empowerment, availability of modern technologies and information, and change in availability (Benin *et al*., 2007). By and large, M&E of agricultural and rural development projects have generally incorporated combinations of the following elements and/or approaches, which are by no means mutually exclusive: logical framework (logframe) approach, results-based framework (simplified logframe), formal surveys, rapid appraisal methods, participatory methods, impact evaluation, cost-benefit and cost-effectiveness analysis (OECD/World Bank 2004c cit in FAO, 2010). The "Managing for Results" initiative of the World Bank led to a resurgence of interest in incorporating more rigorous quantitative evaluation methods based on a counterfactual analysis of outcomes, i.e. how indicators behaved with the project compared to how they would have been without it (Morra Imas and Rist, 2009). These include a range of experimental and quasi-experimental techniques, statistical modelling (e.g. using propensity score matching techniques to ensure comparability), or regression methods. At the same time, the role of qualitative participatory methods (such as community scorecards) and theory-based approaches (analysis involving tracing the logframe from inputs to outcomes and establishing causal linkages), and the advantages of applying a combination of different approaches, are also acknowledged (FAO, 2010). The basic rule of choosing the right M&E methods is that the selection should follow the selection of focus questions, not the other way around (Swanson *et al*., 1998). In practice, it may be desirable to use a selection of methods from the different approaches in order to combine their strong points (van Mierlo, 2011).

However, as EAS systems are ever changing, M&E methods have also been evolving in response to emerging new approaches to development. These increasingly emphasize participatory methods in M&E and their variants, focusing on local communities (FAO, 2010; DFID, 2010). In the past, M&E of EAS were focused on single technology-focused evaluations, e.g. introduction of a new crop variety or new methods of crop or livestock management, following a predetermined view of what the desired capacity gains, adoption and impacts would be (Coutts *et al*., 2019; European Commission, 2017). Today, due to changing EAS systems, M&E of EAS are increasingly under pressure to focus on more complex assessments of changes in agricultural institutions, farming systems, human resource capacity, process of innovation rather than linear milestones and outcomes, together with the impact on the incomes and livelihoods of EAS users (AgriSpin 2017 cit in Coutts *et al*., 2019). In response, efforts have been made to experiment innovative methods for more complex assessments. For example, Babu and others (2020) used a framework based on the Kaleidoscope model of policy process (Resnick *et al*., 2018) to analyse capacities at the systemic, organizational/institutional, and individual levels to assess the prevailing gaps in the implementation of the National Agricultural Extension Policy in Niger State. The increasing complexity of

projects and their integration with government programmes mean that more innovative approaches for EAS M&E will be needed (Lai, 2012):

- Case studies in M&E suggest that quantitative approaches by themselves may not be suitable to all situations. "Rigorous" methods such as quasi-experimental designs need highly experienced agencies to be implemented effectively.
- Projects should consider a wide range of M&E approaches, including complementary use of quantitative and qualitative methods.
- Baseline and assessment surveys should be closely linked at the outset, as integral parts of the overarching project evaluation strategy.
- For baseline establishment, clarity of purpose, commensurate data collection instruments, and realistic time frames are vital for a successful execution.

There is a general need to improve EAS M&E systems in agricultural and rural development. Qualitative approaches and mixed methods are becoming increasingly necessary to assess EAS (Suvedi, 2011). This is particularly true in the field of extension education. One criticism of qualitative methods is the difficulty of aggregating and generalizing findings from a large number of community qualitative exercises. But this issue can be addressed through mixed methods combining qualitative information with quantitative analysis (Lai, 2012). A mixed-methods approach can lead to better understanding and appreciation of the phenomena under evaluation and provide triangulation, convergence, and corroboration of results from different methods (Swanson *et al*., 1998).

Both quantitative and qualitative indicators have been used in the existing literature to measure the performance of EAS. However, M&E systems in practice still tend to resort to quantitative indicators of increased production and productivity, with little attention to more qualitative aspects such as organizational, institutional and capacity issues (Wongtschowski *et al*., 2016). Important indicators include benchmark and baseline indicators as well as input, output, outcome, and impact indicators (Swanson and Rajalahti, 2010). In the beginning, performance indicators were largely input-based, but over time increasingly shifting towards outputs and outcomes (Davis *et al*., 2009). Benin and others (2007) used three sets of indicators to assess the NAADS programme of Uganda, namely, (1) *awareness and adoption of new technologies* (crops, livestock, beekeeping, fish farming), (2) *new technologies and practices adopted and information used after 2000* (improved seeds/planting material, crop management practices, soil fertility management, soil and water management, agroforestry, animal husbandry practices, post-harvest handling practices and marketing information, change in use of improved crop technologies and practices, change in improved livestock technologies,

change in crop yields), and (3) *crop yield, household income, wealth and food and nutrition security* (change in incomes, change in assets, change in food and nutrition security). Non-parametric test where Friedman Two-way analysis of variance was applied to evaluate the quality of public extension services in West Coast District of Western Cape Province, South Africa (Mmbengwa *et al*., 2012). This is done by assessing the EAS impact on the rate of the establishment of start-up farming enterprises, the linkages of emerging farmers to extension agents, frequency of technology dissemination and transfer, the respondents' perception on the EAS quality and marketing information. Bimer and others (2006) used such performance indicators to capture the quality of EAS as (1) the accuracy and relevance of the contents of services, (2) the timeliness and outreach of services, including the ability to reach women and disadvantaged groups, (3) the quality of the partnerships established and the feedback effects created, (4) the efficiency of service delivery, and other economic performance indicators. USAID (2018) used the following EAS characteristics as the conceptual framework for assessing the EAS in Mali: (1) governance structures and policy environment variables; (2) the organizational and management capacities and cultural variables; (3) EAS methods; (4) market engagement; (5) livelihood strategies; and (6) community engagement.

2.4 Challenges

The public EAS system is critical to achieve sustainable agriculture, resilient livelihoods and inclusive growth. However, a poor M&E of its characteristics, performance, and outcomes have to a large extent constrained it from receiving the due recognition and support (including financial, human resources and collaboration) that it deserves from policymakers, donors and other stakeholders in the agricultural innovation system (AIS). While there are considerable interest and efforts to understand the issues related to public EAS in developing countries, rigorous M&E of public EAS interventions are less common (Anderson and Feder, 2004 cit in Sebaggala and Matovu, 2020).

BOX 1: Monitoring and evaluation in the Western Balkan countries

The majority of countries in the Western Balkan region have either just started the systematic monitoring of EAS or do not yet have a well developed system of data collection and interpretation. Monitoring of EAS is fairly advanced in Serbia, Bulgaria and Albania, with Albania having a considerable database on advisors' activities, farmers' needs and the results of on-farm research. However, even in these cases, monitoring is more about examining the activities of advisors than documenting the impacts of advisory work. Moreover, the data collected are not used to their full potential for supporting the EAS system management.

Source: **FAO.** 2011. *Assessment of the human capacity development needs for, and gaps in, the agricultural advisory services in Western Balkans*. Rome, FAO.

Generally speaking, design, reliability of data, and use of data/analysis are three main challenges faced by the EAS M&E systems (Wongtschowski *et al*., 2016). They are often subject to a wide range of other challenges:

- It is vital to have an effective M&E system in place within the public EAS system that is operated by the public EAS system itself. This essentially requires guaranteeing the ownership of public EAS agencies of the M&E system, especially those at the national and grassroots levels. However, ensuring the full engagement of the public EAS agents in the assessment processes (including data collection) may be challenging due to multiples reasons such as heavy workload, lack of capacities, scarce funds, and lack of interest or motivation to undertake unpaid assignments.
- The availability of accurate and updated data and information is one of the biggest limitations. Basic data are difficult to obtain because of the increasingly pluralistic and decentralized nature of today's EAS systems. Decentralization poses some challenges in data collection, as no one at the national and regional levels has up-to-date and accurate information or valid data on the performance indicators of the EAS system and its field-level staff (Khwidzhili and Worth, 2019). Systemic data on EAS are unavailable in most cases.
- M&E systems are challenged to be more sensitive to local contexts and cultural diversity. Cultural norms, government restrictions (for example due to the global coronavirus disease 2019 (COVID-19) pandemic) or security situations may cause potential limitations or delays in data collection. Adaptation and sensitivity to the local context are critical and should be considered from the outset during the preparation phase. This is however barely the case in practice.
- Lack of self-M&E capacity especially at the central government level is one of the major limitations in many countries. To enhance the capacity, building a team of public M&E specialists within the public EAS system and providing relevant training on the M&E methodology will enhance the M&E process and results. However, both are largely absent in many developing countries. Lack of human resources and the associated backward capacities also account for poor M&E (Lai, 2012). Lack of skilled M&E personnel, especially at the field level is a major constraint, exacerbated by a lack of M&E training either at pre-service or post-entry. Problems articulated ranged from the issues of work conditions and lack of a proper M&E structure to low priority given to M&E.
- The increasing pluralism of EAS in terms of types of organizations providing these services (and of their objectives, methods, and approaches) has formed a complex system embedded within an AIS (Davis and Heemskerk 2012). This complexity makes it even more difficult to monitor and evaluate the public EAS system (Davis *et al*., 2020; Faure *et al*., 2016). M&E

under a pluralistic context involves keeping track of the activities of a variety of actors providing a range of service (Christoplos *et al.*, 2012).

- The transition of public EAS to become more demand- and market-oriented requires building the competencies of extension institutions, managers, and field-level staff to meet the new challenges attached to it. Accordingly, M&E are first challenged to assess whether capacities have kept pace with these changes (Christoplos *et al*., 2012). Second, they are expected to adopt participatory and inclusive approaches so as to have a sound understanding of farmers' demands[2] and identify possible gaps in the existing EAS which have prevented the services from meeting their needs. This will be critical to tailor farmer-centred and demand-driven public EAS and generate evidences for EAS reforming initiatives. Third, the M&E process is to be made more transparent to all related EAS stakeholders and respectful of individual privacy and data ethics.
- In terms of data analysis, it remains a crux as how to control factors that influence agricultural outcomes such as climate, weather events, availability and prices of inputs, market access, and farmers' characteristics, among other things (Wongtschowski *et al*., 2016). Furthermore, assessment of EAS performance tends to be undermined by a number of inherent methodological challenges such as endogenous placement bias, selection bias and heterogeneity issues related to farm characteristics (Birkhaeuser *et al*., 1991; Owens *et al*., 2001; Anderson and Feder, 2004; Cerdán-Infantes *et al*., 2008; Betz, 2009 cit in Sebaggala and Matovu, 2020). Besides, the M&E results can be inaccurate due to a lack of farmer involvement in the definition and measurement of good performance in many performance measurement systems (Bitzer, 2016).

2.5 Lessons learned

Not only are M&E an integral part of any successful EAS programme but there is also a need to "embrace error" which allows for individual and collective learning (Farrell and Mcdonagh, 2012). General lessons from the EAS M&E practices suggest the need for (1) greater simplicity in M&E, and for it to be better integrated into EAS systems and its management processes, (2) sustained support and commitment by the public EAS staff, and other key stakeholders at the field and community levels, (3) participatory and results-oriented survey methods, (4) M&E to be seen as a tool for management,

[2] According to the evidences from India, farmers' expectation from the extension providers are improvement in income, financial security, productivity (yield) and their participation in service planning, implementation and evaluation (Joshi and Narayan, 2019).

not as an obligation imposed from the outside, with EAS staff mechanically completing forms and project managers seeing their task merely as the collection of data for writing progress reports, and (5) capacity building in M&E system design and implementation (FAO, 2010). On this basis, a set of guiding principles for enhancing result-oriented M&E systems for the public EAS system are proposed, including:

- Throughout the M&E cycle, namely from conceptualization, preparation, appraisal to implementation and beyond, focus attention on all relevant stakeholders.
- During the preparation, invest adequate time and resources in M&E system design, with provision for refinement and evolution over the course of implementation.
- Ensure that the performance indicators are appropriate to their respective hierarchical level along the results chain.
- Undertake updating of baseline data early, i.e. during the start-up.
- Start implementation of the M&E system only when competent staff are in place.
- Ensure that clear institutional linkages are established between those responsible for operating the M&E system and others charged with implementing specific project components or subcomponents.
- Keep in mind that M&E is first and foremost a tool for EAS system management.

Discussions on how to improve M&E of EAS continue. A variety of views have been observed. For instance, Davis and others (2012) argued that some of the most important components of M&E are: (1) participation by all key stakeholders; (2) the clear definition of objectives, indicators, outputs, outcomes, and desired impact; (3) continual assessment throughout the investment period; and (4) the collection of baseline data. Some scholars suggested pathways to strengthen M&E systems in response to changing EAS systems. For example, Gujit (2007 cit in DFID, 2010) stated that the following critical considerations must be taken into account when designing appropriate M&E systems:

- M&E design should reflect an understanding of social change (including evolving development policies and strategies) and underlying assumptions regarding its causes.
- M&E must make the most of available indicators and understand their limits.
- M&E of system change should ensure the capacity to facilitate critical reflections on power, justice, and policy processes as well as the ability to engage in learning processes.

- M&E should establish clear and ethical standards that appropriately address unequal relations between North and South, donors and grantees, external experts and local people.

Horton and Mackay (2003 cit in DFID, 2010) identified several important considerations for enhancing the overall benefits of M&E. These include:

- Stakeholders should be included in the process of M&E.
- M&E of EAS systems should address the broader complexity of the AIS from a pro-poor perspective.
- M&E should include achievements that are important to stakeholders instead of focusing only on easily measured achievements.
- M&E should draw evidence from the full range of stakeholder groups that results in findings that transcend a limited point of view.
- Framework of M&E using the constructs of many disciplines to address the broader, more complex processes that are of concern to stakeholders.
- Equip stakeholders to address their responsibilities by identifying and seeking ways for them to use results early on.
- Select methods that are appropriate for the circumstances that stakeholders represent rather than an overall best method.
- Develop the multidisciplinary competence of staff and the means for organizations to productively utilize this competence.

Suvedi and Stoep (2016) suggested strategies for improving M&E practices as follows:

- integrating evaluation into the design of projects;
- choosing appropriate evaluation criteria and indicators;
- measuring and reporting objectively;
- selecting appropriate evaluation tools;
- selecting appropriate data sources;
- carefully selecting, training, and monitoring data collectors;
- selecting randomized and/or representative samples;
- selecting a sample using random (probability) sampling;
- appropriately analysing data; and
- communicating and utilising evaluation findings.

3. Logical framework

This guide proposes a systemic, holistic and easy-to-use methodology that is multiscalar, multisectoral, and multidimensional for the self-monitoring and self-evaluation (self-M&E) of the public EAS system. An effective application of this methodology is expected to help identify the gaps and loopholes in the existing public EAS system and generate evidences for strengthening and reforming it. It proposes an overall M&E framework that (1) covers the principal agricultural sectors, including agronomy, animal husbandry, aquaculture, and agromachinery; (2) allows for a multidimensional diagnosis of the national public EAS system in terms of system structure, functions, capacities, enabling environment, and key outputs and outcomes; (3) combines the M&E activities at both national and grassroot levels; and (4) envisions for the grassroots level different M&E activities according to the five major links throughout the EAS delivery process, namely, inputs, activities, outputs, outcomes, and impacts. These five links form a theory of change (ToC) that considers that the access to quality EAS (inputs) and their effective use (activities in terms of gaining information, knowledge, advice, facilitation, capacities) by farmers (and other value chain actors) are crucial for addressing their challenges and improving their farming practices (outputs and outcomes) and thereby enhancing their awareness, knowledge and capacities and changed their attitudes, behaviour and practices, which finally contributes to food and nutrition security, income generation and greater resilience (impacts) (Sulaiman V *et al*., 2022a).

BOX 2: Monitoring vs evaluation

Monitoring is a continuous assessment that aims at providing all stakeholders with early detailed indication on the progress or delay of an ongoing activity/project. It is a whole-process oversight of the implementation stage of the activity/project. Its purpose is to show whether the outputs, deliverables and schedules as planned have been reached or respected so that action can be taken timely to address the limitation. Unlike evaluation which also assesses the outcomes and sometimes the impact in the long term, monitoring, as a short-term assessment, does not take into account the outcomes and impact.

Monitoring is a pre-condition for evaluation. A common set of data needs to be systematically collected to inform the key evaluation criteria usually used in evaluation (relevance, efficiency, effectiveness, sustainability, and impact). Research contributes to the design of methods, and many evaluations are carried out by researchers to produce knowledge useful for policymakers.

Source: **Faure, G., Davis, K.E., Ragasa, C., Franzel, S. & Babu, S.C.** 2016. *Framework to assess performance and impact of pluralistic agricultural extension systems: The best-fit framework revisited.* IFPRI Discussion Paper 01567. Washington, D.C., IFPRI.

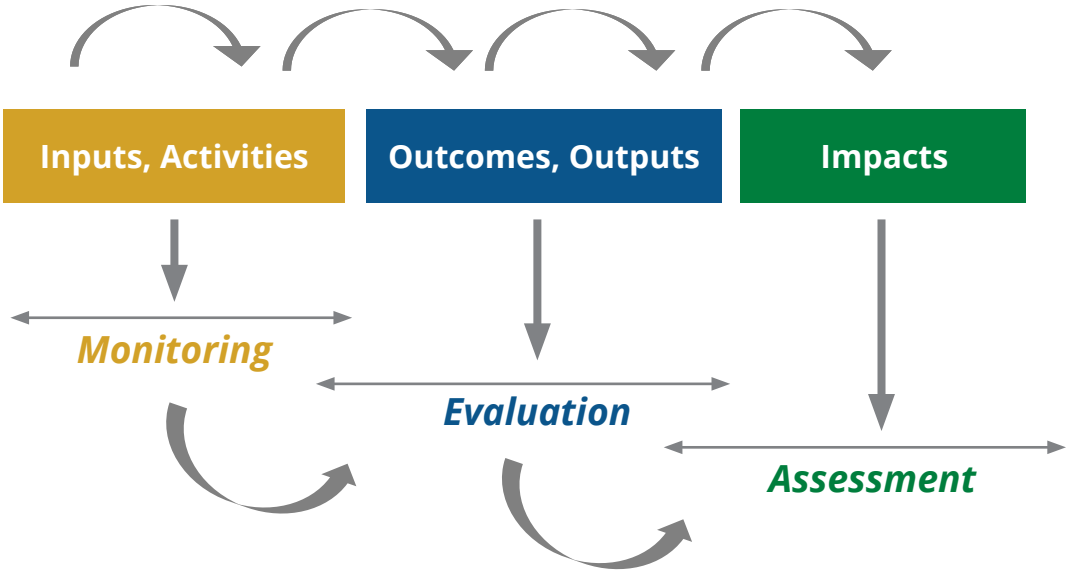
van Mierlo, B.C. 2011. *Approaches and methods for monitoring and evaluation.* Wageningen, Wageningen University.

According to the nature of the five links of the ToC and their location along it, this guide proposes an M&E framework that consists in different activities for each link, namely, monitoring, evaluation, or assessment (Figure 1). Monitoring activities focus on inputs and activities, with the aim to measure whether (1) the preconditions of quality EAS are secured or put in place, including capacities of the public EAS providers, human and financial resources, enabling environment, and infrastructure (inputs); and (2) effective actions or work have been performed by the public EAS providers to supply various services according to users' demands and needs (activities). Evaluation activities look into (1) the extent to which the activities carried out by EAS providers contribute to producing accessible services demanded by users (outputs); and (2) the changes that have happened after that EAS users have accessed and deployed these services (outcomes). Assessment activities concern the long-term socioeconomic and environmental results that EAS have generated, directly or indirectly (impacts). These results are closely related to the objectives of sustainable development of the agricultural sector and rural communities alike. For the purpose of this guide, the focus of the proposed M&E concept is on the monitoring of inputs and activities and the evaluation of outputs and outcomes.

This logical framework couples the need of impact investing and making policies aimed at strengthening the public EAS system at the national level and identification of gaps and capacity needs in service provision at the

grassroots level. Different M&E activities, occurring in a time sequence, concern different EAS actors who have different priorities and interests (Table 2). For the monitoring activity, EAS agents are the key concerned actors, who need the monitoring data for undertaking the quality control of EAS and timely addressing issues at the institutional, financial, mandates, human resources, and infrastructural levels. For the evaluation activity, policymakers, independent experts, and EAS agents are all concerned as they seek to understand the efficiency and effectiveness of public EAS and thereby perform the investment analysis. For the impact assessment, policymakers, independent experts, and donors are the main concerned actors, who need to know the economic, social, and environmental impacts of EAS. The society and general public may also be concerned for communication activities.

FIGURE 1. **Theory of change of the proposed monitoring and evaluation framework**



Source: Authors' own elaboration.

TABLE 2. **Monitoring and evaluation activities, indicator frameworks, and priorities of different extension and advisory service actors**

M&E activities	Target activities	Indicator frameworks	Priorities of different EAS actors					
			Farmer	EAS agency	Policy-maker	Donor	Society & general public	Expert
Monitoring	Inputs and activities	EAS processes (institutional, human resources, mandates, financial, infrastructural and EAS activities)		X				
Evaluation	Outputs (at farmer/farm, regional and national levels)	Number and percentage of farmers/farms accessing public EAS at grassroots, regional and national levels		X	X			X
	Outcomes (at farmer/farm, regional and national levels)	Farmer-level knowledge, attitude, practice and skills improvement at grassroots, regional and national levels	X	X	X			X
		Farm-level yields, incomes, profits, costs at grassroots, regional and national levels	X	X	X			X

M&E activities	Target activities	Indicator frameworks	Priorities of different EAS actors					
			Farmer	EAS agency	Policy-maker	Donor	Society & general public	Expert
Assessment	Impacts (economic, social and environmental)	Community or above level income, livelihoods, social and environmental well-being			X	X	X	X

Source: Authors' own elaboration.

4. Rationale and objectives

4.1 Rationale

It is widely acknowledged that an effective, adaptive public EAS system plays a critical role in helping transform agrifood systems. Currently, many developing countries are reforming or attempt to reform their public EAS system. The aim is to better meet national agricultural development goals and farmers' different and changing needs. Therefore, it is crucial to establish appropriate and comprehensive M&E systems which can enable a multidimensional and holistic understanding of the public EAS system. On this basis, decisions on policymaking and investment can be made. Such M&E systems are critical to ensure and maintain proper operations and functions of the national public EAS system, specifically:

- National research, education and public EAS systems are the three pillars that support sustainable agricultural development of a certain country. Countries need to generate concrete evidences on the performance of the public EAS system related to the country indicators of the SDGs to which EAS are contributing, in particular SDGs 1 (No Poverty), 2 (Zero Hunger), 5 (Gender Equality), 10 (Reduced Inequalities) and 13 (Climate Action).
- Effective M&E systems are needed to ensure the relevance, efficiency and effectiveness of the public EAS system in providing essential public services to smallholder farmers in particular. They are also critical to enhance the adaptivity and resilience of the public EAS system to challenges such as climate changes, natural disasters and shocks, market failures, etc.
- M&E systems can underpin the strengthening and reform of the public EAS system and facilitate multistakeholder co-learning, collaboration and co-innovation within the AIS, of which the public EAS system is an integral component.

4.2 Objectives

It is widely acknowledged that a well functioning pubic EAS system is critical to support, facilitate and promote agricultural innovations needed for transforming agrifood systems. In 2020, the 27th Session of the Committee on Agriculture (COAG 27) of the FAO Council requested the FAO to strengthen its strategic guidance and technical support for Members in promoting institutional reforms, the reorientation of services, and development of the technical and functional capacities of organizations within the public EAS system. It also demanded the FAO to strengthen its technical support to generate evidence for informed policy and investment decisions. The COAG recognized the important role that the public EAS system plays in achieving sustainable rural development and recommended that the FAO plays a greater role in assisting countries and local communities in the development of their public EAS M&E systems through comprehensive needs assessments (FAO, 2019). These recommendations were echoed at the FAO's international workshop on "Global Review and Assessment of Public Agricultural Extension and Advisory Service Systems" held in February 2022.

In line with these recommendations, this guide was developed with a "systems thinking". It proposes, a systemic, holistic and easy-to-use methodology for the public EAS system to monitor and evaluate itself. Through self-M&E, evidences can be generated for identifying gaps and pathways to strengthen and reform the public EAS system. The proposed M&E methodology can be deployed to achieve the objectives as follows:

- supporting evidence-informed policymaking and impact investing. This will help improve the accessibility, affordability, adaptability and accountability of the public EAS system;
- informing or planning actions to facilitate and guide a successful transition of the public EAS system towards a demand-driven and better coordinated pluralistic system. Such a renewed public EAS system can contribute to the national agricultural development, meet farmers' needs, and ultimately help achieve the SDGs;
- ensuring the effectiveness and efficiency of the public EAS system to provide essential services to smallholder farmers in particular; and
- strengthening M&E capacities at the national and grassroots levels with a participatory approach, which actively involves key stakeholders to facilitate collaborative learning and capacity development.

Following a multiscalar approach, this guide is aimed to underpin the M&E at the national and grassroots levels, specifically:

- **At the national (macro) level**, namely, the national public EAS system level, it assists policymakers and investment decision-makers in planning the reform process for transformative agricultural development, realigning priorities, and better making efforts of investments, innovation policies, capacity development, etc.

- **At the grassroots (micro) level**, namely, township, village, farmer community or equivalent level, it assists local public EAS agencies or agents in identifying capacity needs and gaps in service provision to improve service quality and increase impact. Besides, it facilitates farmers or farmer organizations to feedback their needs to help improve and strengthen the public EAS system.

5. Monitoring and evaluation module at the national level

M&E at the national level are emphasized in this guide for two reasons. First, they are critical to assess the performance of the entire public EAS system from a systemic perspective. Therefore, a straightforward macro (systemic) diagnosis is needed to examine the functionality and effectiveness of the national public EAS system in terms of accessibility, affordability, adaptability, accountability, and achievement. An effective public EAS system at the national level generally implies that subnational EAS systems are effective too. Second, the national level allows for an overview of the structure of the public EAS system. It is necessary to check whether the national public EAS system has an "upright pyramid-like" (decentralized, devolved) structure or an "inverted pyramid-like" (centralized, bureaucratic) structure. This will pave the way for identifying gaps in the existing public EAS system, which may include, but not limited to, understaffing and underfunding at the grassroots level, lack of political will and enabling policy, poor coordination and so on.

5.1 Introduction

Different institutional reforms of the public EAS system have been experimented in many countries since the 1990s. The results have been largely varied in different countries, with failure of reform not being unusual. To underpin efforts and initiatives aimed at EAS reform and strengthening, a self-M&E system is to be integrated into the national public EAS system to help identify existing gaps and loopholes. The proposed M&E module focuses on the structure and functions of the national public EAS system. It also identifies such M&E priorities as enabling environment, capacities and key outputs and outcomes. This module seeks to engage multiple stakeholders, especially policymakers

and investors to make informed decisions in the following aspects:

Policy: Policymakers and investors need to benchmark and assess the performance of public EAS sectors at the national level in terms of their capacities, efficiency, and effectiveness for providing essential public services in agriculture to clients (including smallholder farmers).

Investment: Investment implies committing support to a system, project or activity to gain a desired return. Investment in the public EAS system is a long-term process. Projections of future investments in a public EAS system will benefit from the analysis of its M&E results. This can provide evidences for making decisions and adjustments.

Institutional setting: Stakeholder engagement and learning in the M&E process of the public EAS system often lead to institutional and technical changes to overcome constraints and challenges. M&E of the public EAS system can contribute to the institutional assessments by multiple approaches to capture existing and potential changes needed within and among institutions and develop action plans for their strategic reforms.

Action: Through a well functioning M&E system, key actors (or stakeholders) and institutions involved in the public EAS system can get a wide range of information to learn about their strengths, gaps, weakness and functionality. The public M&E systems have the potential to provide the necessary information to stakeholders to develop and implement action plans for supporting effective management and coherent policy-making.

5.2 Key monitoring and evaluation elements

The public EAS system has been evolving to become more and more pluralistic, market-oriented and demand-driven. In addition to providing essential public services to clients, it is also expected to promote knowledge and innovation brokerage, farmer empowerment, gender equality and youth inclusion, and the integration of new technologies and tools such as digital innovations into public EAS. Therefore, modernizing and revitalizing the public EAS system is becoming an increasingly urgent need. To develop and implement an effective M&E module at the national level, system structure, functions, enabling environment, capacities, and key outputs and outcomes of the public EAS system are the key M&E elements.

5.2.1 System structure

First and foremost, it is of great importance to have an overall review of the structure of the public EAS system. Generally, there are two types of system structure: While one features an "inverted pyramid-like" structure, the other has an "upright pyramid-like" structure. In the first case, the majority of human and financial resources stay at the central government level, while the subnational levels, especially the grassroots level, are understaffed and underfunded. As a largely bureaucratic structure, it favours centralized decision-making. In contrast, in the second case, the public EAS system is decentralized, with staffing, funding, and decision-making devolved to the subnational levels. Problems may arise due to decentralization, such as lack of political will and enabling policy, lack of financial resources, poor coordination, etc. It is no easy task to monitor and evaluate the structure of a public EAS system at the national level, which is composed of at least two key dimensions, namely, institutional and governance.

Institutional structure: In the majority of countries worldwide, the public EAS system is composed of institutional arrangements at different levels, from grassroots level upward to national level. In most countries, the institutional arrangements at the national level lay the foundation for creating a modern, nationwide public EAS system. In general, this public EAS system operating at four administrative levels, namely, national, regional (provincial), city (or prefecture), and grassroots levels (township, village or equivalent), and involving different technical sectors (agronomy, animal husbandry, aquaculture, agromachinery and forestry, etc.). To evaluate the institutional structure of a public EAS system:

- First, check the completeness of the structure, looking at whether the structure (or network) covers the important agricultural geographical regions. Also check the completeness of specific technical sectors such as agronomy, animal husbandry, aquaculture, agromachinery, agroecology, etc. to meet farmer demands.

- Second, check the institutional setting at different administrative levels. The institutions at the grassroots level (township, village or equivalent) are the most important. This level functions as the basis of the public EAS system that directly provides the most essential services to farmers.

- Third, check the structural linkages of public EAS institutions with other key stakeholders of AIS such as research, education institutions and farmer organizations.

- Fourth, check the structure and compositions of the public institutional setting from the top to the bottom administrative levels.

Governance structure: Governance structure of the public EAS system refers to the administrative and organizational structures and processes within which agricultural EAS are formulated, provided, and delivered. At the heart of governance structure are the complex questions of how public EAS are steered, at what level decisions for budget, design, human resource management and implementation are made, and how authority is exercised (Bitzer *et al*., 2016). Monitoring and evaluating the governance structure require focusing on public EAS at different levels in human resource management and financing EAS as well as the linkages and coordination across these different levels. The M&E of the governance structure is especially important at the grassroots level. When the decision-making on staffing and funding of grassroots public EAS agencies is devolved to local governments (township or below), worsening functionality of the public EAS system is likely to occur. This is because that local governments may have to reduce investment and support for public EAS agencies due to the constraints of their financial and human resources.

5.2.2 System functions

The most important function of the public EAS system is that it should be able to provide the essential public services needed to achieve the national agricultural development goals while meeting farmers' needs. When monitoring and evaluating the functions of the public EAS system, the key questions needed to be answered include: What services are available and to whom? Are these essential public services available and adequate for farmers? What capacities or supporting policies are in place or needed to provide these services? Mandates are the entry point for monitoring and evaluating the functions of the public EAS system. They allow checking both its institutional functions and operational functions related to field activities and the existing services provided.

Mandates: The mandates of the public EAS system should be defined by the agricultural development goals of national governments and requirements of farmers, and preferably legitimated by national laws, regulations or EAS policies and secured with sufficient public budgets. The mandates of public EAS should be set up in two dimensions. On the one hand, mandates should cover the key agricultural sectors, including agronomy, animal husbandry, aquaculture and agromachinery, etc. On the other hand, they should include all key functions and responsibilities of public institutions in charge of agricultural EAS, such as (1) public services, including crop pest monitoring and forecasting, animal disease detection and diagnostics, soil testing and monitoring, soil moisture monitoring, crop development monitoring, seed quality testing, inputs quality testing, appraisal and release of new crop varieties, fish and animals, agromachinery quality and safety testing, meteorological service, early warning of risk and disaster,

etc.; (2) law enforcement, including plant and animal quarantine, seed quality control, quality control of inputs such as fertilizers and pesticides, crop and fish and animal varieties management, etc.; and (3) technical EAS, including transfer of knowledge generated by agricultural research, market linkages, farmer and EAS agent training, field trials, and experiments and policy advocacy, etc. To monitor and evaluate the mandates of the public EAS system, it is necessary to check both its institutional functions in terms of organization and management and operational functions related to field activities and the existing services provided. The M&E should focus on operational functions, namely, examining whether mandates cover the key agricultural sectors and whether they include the above-mentioned key functions and responsibilities of public EAS institutions.

5.2.3 System capacities

More attention is to be paid to the M&E of individual and institutional capacities of the public EAS system. M&E of individual capacities target at both technical capacities and functional capacities of public EAS agents. Technical capacities refer to the technical skills and expertise of public EAS agents or agencies, while functional capacities focus on soft skills and system coordination and management. M&E of capacities aim at identifying and analysing existing or available capacities and lacking capacities for achieving a desired objective. Possible questions may include: What are the capacities available? What are the gaps and needs? What are the capacities for? For whom are the capacities? What are the capacities needed to perform a specific mandate or a group of mandates? What are the main challenges, constraints and opportunities related to fulfilling these mandates?

Staff capacities: The capacities of a certain public EAS system mainly depends on its human resources. Indeed, healthy and high-quality human resources are vital to a healthy and sustainable development of the public EAS system. The public EAS system must be staffed with agricultural professionals with adequate knowledge and skills, experience, vision, motivation, and abilities to provide essential public agricultural EAS to farmers. Generally speaking, major challenges of the public EAS system are a lack of effective human resource development system and inadequate staffing to deal with emerging issues, such as digitalization, market linkages and climate change. The farmer-to-agent ratio is generally recognized as a highly relevant indicator for monitoring the quantity of human resources. To evaluate the human resources of the public EAS system, firstly, it is necessary to look at the composition of professional staffs in different geographical regions and at different levels in relation to farmers' needs and national agricultural development goals. Secondly, attention should be paid to their technical backgrounds, checking whether they cover such specific technical sectors as crop production, animal husbandry, aquaculture, machinery and

agroecology, etc. in line with farmers' needs. Thirdly, a healthy structure of human resources should have a balanced age structure, including reasonable proportions of junior, mid-level, and senior agents with qualified education background and experiences in agricultural EAS. Finally, it is of equal importance to monitor and evaluate the functional capacities of public EAS agents, such as facilitation, knowledge and innovation brokerage, communication, mentoring and training, farmer empowerment, gender mainstreaming and youth inclusion, digital literacy, etc.

Institutional capacity: The institutional capacity of public EAS system refers to the organizational capacity that requires the building of linkages between producers and users of knowledge. It also concerns institutional settings for knowledge sharing and interactive learning. To monitor and evaluate the institutional capacity of public EAS system, the following aspects are to be considered: (1) leadership or management of the public EAS system that enables interaction and co-learning among actors; (2) organizational ability to set up multistakeholder mechanisms at the national level to facilitate EAS knowledge sharing and interactive learning; (3) coordination of the sustainable development of pluralistic EAS systems across the country; and (4) facilitation of interministry dialogue or policy dialogue within EAS-related sectoral actors and clear mandates to act on these; (5) orientation of legislators of relevant parliamentary working groups (for instance); and (6) establishment of incentive and funding schemes to provide and facilitate public EAS.

5.2.4 Enabling environment

A favourable legal framework and well developed infrastructure are critical to support the public EAS system. The M&E of the enabling environment of the public EAS system should take into account funding mechanism, infrastructural set-ups, and supportive laws and policies.

Funding mechanism: The principal source of funding of public agricultural EAS systems should come from the public budget of governments. However, in many cases, public funds, occurring mainly at the national level, are far from being sufficient to maintain the functionality and efficiency of the entire public EAS system. To monitor and evaluate the funding mechanism, it is necessary to examine firstly the portion of funding coming from different levels of governments and secondly the degree of sufficiency for the ordinary operation and management of the public EAS system. In most cases, the funding for public EAS is shared between national and subnational governments, while various other mechanisms co-exist. In many countries, public funds are largely used for staff salaries, with limited remaining resources for operational expenses. This often results in a lack of motivation and inadequate services provided to farmers.

Infrastructural setting: A well functioning public EAS system consists of necessary infrastructure, i.e. offices, meeting and residential places (physical spaces), farmer training facilities (e.g. computers, projectors, vehicles, etc.), experimentation and demonstration plots, and technical promotion, communication and advocacy facilities (videos, camera, and ICT facilities), and detection and testing labs, etc. Ensuring adequate infrastructure is especially important for strengthening the public EAS system at the grassroots level. To monitor and evaluate the infrastructural setting, the following aspects are to be focused on: (1) availability of office spaces that are adequately equipped; (2) basic travel vehicles (motorbikes, bicycles or cars); (3) fields or farms for experiments and demonstration of new technologies and varieties; (4) farmer training venues and facilities (computers, projectors or meeting rooms, etc.); and (5) well equipped labs for testing seeds, pesticide residue, fertilizer or soil at the regional level or national level as necessary.

Supporting policies: In accordance with national agricultural development goals, it is necessary to check whether EAS-related laws, regulations and policies are in place, review the existing laws, regulations and policies, and assess whether they need to be legislated based on the gaps identified. The scope of enabling laws, regulations or polices should cover such aspects as institutional arrangement, human resource development, mandates and responsibilities, sustainable financial mechanisms, infrastructural setting and management, M&E, legal liabilities and so on. In general, agricultural policy development is a long and complex process, involving the full participation of all stakeholders. In most countries, developing a national agricultural policy needs 3-5 years, or even over ten years in some cases from its initial formulation to the endorsement. Formulation of a recommended public EAS policy may include the following necessary procedures: (1) needs assessment and the related report preparation; (2) consultations on the needs assessment report; (3) prepare a draft version of the policy; (4) consultations on the draft version; (5) review the results of consultations and revise the consulted draft version; (6) develop the final recommended version of the policy; and (7) submit the final recommended version to relevant government or legislative bodies.

5.2.5 Key outputs and outcomes

It is critical to look at the outputs and outcomes of the national public EAS system from a systemic perspective. Specific outputs and outcomes can be aggregated into 5A, namely, accessibility, affordability, adaptability, accountability, and achievements. The 5A can offer a straightforward macro diagnosis of the functionality and effectiveness of the national public EAS system.

Accessibility: The majority of the rural population in most developing countries are smallholder farmers involved in subsistence farming. These farmers are the largest and most difficult group for agricultural EAS to reach. Public EAS are the chief source for them. "Accessibility " refers not only to the physical proximity of services, but to their affordability, sociocultural appropriateness and context-specific relevance (from the demand side) as well as to their availability (from the supply side). EAS are considered accessible and inclusive if they are responsive to resource-poor and vulnerable farmers, especially women and youth and tailored to the multiple capacities, needs and demands of farmers. To evaluate the accessibility, it is necessary to, firstly, survey the general service access percentage by farmers in the sample agricultural geographical regions, and also the percentage of specific technical service sectors such as crop production, animal husbandry, aquaculture, agromachinery and agroecology, etc. Secondly, the EAS accessibility to the most vulnerable farmer groups such as women, youth and poor farmers needs to be examined.

Affordability: Affordability of EAS is essentially about inclusiveness and equity, especially for smallholder farmers and other vulnerable farmer groups. Many tasks of public EAS have a public-good nature, including regulation, quality control in the supply chain, the coordination of service provision, and natural resource management, as well as the provision of services to marginal or poor farmer groups. These groups are often unlikely to access or afford private EAS. To evaluate the affordability, it is necessary to look at the shares of public EAS in the total public funding, unit cost of provision of free EAS to smallholder farmers, and comparative unit cost of public EAS versus non-public EAS, etc.

Adaptability: The socioeconomic and policy environment in which public EAS are formulated and operated is ever-changing. Emerging challenges such as climate change, COVID-19 pandemic, and so on bring about shocks to the public EAS system which will affect their relevance, efficiency, and responsiveness. Consequently, the goals and mechanisms of the public EAS system must change accordingly to meet new requirements. The public EAS system worldwide is increasingly expected to be sufficiently flexible and responsive to a broad set of local, national and global pressures that concern multiple sectors across value chains. To evaluate the adaptability, it is necessary to check whether the working mechanism of the public EAS system is demand-driven or not, and whether it can address emerging challenges such as climate change, outbreaks of transboundary plant pests and animal diseases, COVID-19 pandemic, agricultural digitalization, etc.

Accountability: Accountability refers to the responsibility that a service provider (public agents) has towards its clients (downward accountability) and its donors or bureaucratic hierarchies (upward accountability).

Accountability is intrinsically linked to governance, and the extent to which clients have a say at higher levels of the public EAS system. It is crucial to ensure the relevance, quality and demand-orientation as well as effectiveness of services in responding to demands of their clients in the long run. Evaluating accountability requires investigating whether (1) effective and participatory EAS accountable to farmers are in place or not; (2) performance of public EAS agents is evaluated in a participatory approach (namely, with or without the engagement of farmers); and (3) accountability measurements of EAS agencies and public EAS agents take into account the involvement of the actual EAS recipients in the reporting and feedback system at various levels.

Achievements: Achievements consist of data that indicate the achievement of agricultural development goals following the intervention of agricultural EAS. These goals normally have economic, environmental and social implications which altogether can help understand agricultural and rural progress. Indicators on agricultural productivity, agricultural innovation's impact on agricultural gross domestic product (GDP), farmers' livelihoods, natural resource management, comprehensive mechanization level and so on are commonly used to measure achievements.

5.3 Indicator frameworks

63 indicators were selected for monitoring and evaluating public systems at the national level. Among them, eight are about the system structure (institutional structure and governance structure), 20 about system functions (mandates in terms of technical services, public services, and law enforcement), five about system capacity (staff capacities and institutional capacity), 12 about enabling environment (funding mechanism, infrastructural setting, and supportive policies), and 18 about key outputs and outcomes (accessibility, accountability, affordability, adaptability, and achievements). The selection of indicators for this framework was guided by the objective to generate evidences on the structural, functional, capacity, enabling environment, and key outputs and outcomes of the public EAS system, as well as the factors that directly influence their operation and the main results.

BOX 3: Dimensions of capacities

System capacity refers to the overall context in which changes are taking place (Baser and Morgan, 2008). In other words, through this dimension, whether (and to what extent) the current conditions promote capacity strengthening for agricultural EAS are assessed. As in the case by Babu and Blom (2014), this includes the smooth functioning of different stages of the policy process (identification, research, strategy development, implementation, monitoring and evaluation, and strategy revision).

Institutional capacity is seen through the 5C approach (Baser and Morgan, 2008). The 5C approach is described as an organization's capability to act and commit; deliver development objectives; adapt and self-renew; relate to external stakeholders; and achieve coherence (Babu and Blom, 2014).

Individual capacity is often thought of as one's knowledge, skills, and attitudes—that is, one's awareness and understanding of a particular situation, issue, or area; one's technical ability to react, predict, analyse, or solve in a critical way; and one's personal motivation to apply oneself to the task at hand.

Source: **Davis, K., Babu, S.C. & Ragasa, C.**, eds. 2020. *Agricultural Extension: Global Status and Performance in Selected Countries*. Washington, D.C., IFPRI.

The key objective of the M&E of the public EAS system at the national level should focus on helping ensure its functionality, effectiveness and capacities to provide essential public agricultural EAS to smallholder farmers. Table 3 below provides the framework of commonly used indicators for reference. Specific indicators are to be defined and applied in accordance with country-specific situations and conditions. Therefore, it is worth noting that the proposed indicator framework, when applied, must be adjusted and adapted in line with the country requirements and contexts.

TABLE 3. **Indicator framework of the public extension and advisory service system's monitoring and evaluation at the national level**

Item	Indicators	Data sources
1. System structure		
1.1 Institutional structure		
1.1.1 Geographic coverage	IND./NAT.1. Percentage of townships or villages or farmer communities that are covered by public EAS	National statistics
	IND./NAT.2. Percentage of regions, districts or provinces that are covered by public EAS agencies	National statistics
1.1.2 Technical coverage	IND./NAT.3. Coverage of production-related public technical EAS based on farmers' needs	EAS agency survey
	IND./NAT.4. Coverage of post-production public technical EAS based on farmers' needs	EAS agency survey
1.2 Governance structure		
1.2.1 Decision-making	IND./NAT.5. Management model	EAS agency survey

Item	Indicators	Data sources
1.2.2 Funding	IND./NAT.6. Total publicly funded budget as a percentage of agricultural GDP	EAS budget execution report
	IND./NAT.7. Publicly funded operation budget as a percentage of total public EAS budget	EAS budget execution report
	IND./NAT.8. Publicly funded staff budget as a percentage of total public EAS budget	EAS budget execution report
2. System functions		
2.1 Technical services	IND./NAT.9. Field trials and demonstration of new varieties, inputs, technologies, etc.	Farmer/farm survey
	IND./NAT.10. Farmer training	Farmer/farm survey
	IND./NAT.11. Technical extension and advisory service	Farmer/farm survey
	IND./NAT.12. Technical policy advisory and advocacy	Farmer/farm survey
	IND./NAT.13. Technical support for agroproducts certification and marketing	Farmer/farm survey
2.2 Public services	IND./NAT.14. Crop pest monitoring and forecasting	Farmer/farm survey
	IND./NAT.15. Animal disease detection and diagnostics	Farmer/farm survey
	IND./NAT.16. Soil testing and monitoring	Farmer/farm survey
	IND./NAT.17. Soil moisture monitoring	Farmer/farm survey
	IND./NAT.18. Crop development monitoring	Farmer/farm survey
	IND./NAT.19. Agromachinery quality and safety testing	Farmer/farm survey
	IND./NAT.20. Meteorological service	Farmer/farm survey
	IND./NAT.21. Early warning of natural disaster	Farmer/farm survey
	IND./NAT.22. Safety and quality testing of agro-products	Farmer/farm survey
	IND./NAT.23. Providing marketing information	Farmer/farm survey
2.3 Law enforcement	IND./NAT.24. Plant and animal quarantine	EAS agency survey
	IND./NAT.25. Verification, registration, introduction of new varieties	EAS agency survey
	IND./NAT.26. Implementing one health laws or policies	EAS agency survey
	IND./NAT.27. Inputs quality testing and market supervision	EAS agency survey
	IND./NAT.28. Judicial detection and arbitration of production accidents	EAS agency survey
3. System capacities		
3.1 Staff capacities	IND./NAT.29. Agricultural technical specialists as a percentage of total public EAS staff	National statistics or EAS agency survey
	IND./NAT.30. Average educational degrees in agriculture science of public EAS staff	National statistics or EAS agency survey
	IND./NAT.31. Average days of agricultural technical refresher or updating training received by each public EAS staff in one year	EAS agency survey
3.2 Institutional capacities	IND./NAT.32. Number of public EAS agencies per million farmers	National statistics or EAS agency survey
	IND./NAT.33. Number of public EAS agents per million farmers	National statistics or EAS agency survey

Item	Indicators	Data sources
4. Enabling environment		
4.1 Funding mechanism		
	IND./NAT.34. Public expenditures on public EAS as a percentage of total agricultural GDP	National statistics or EAS budget execution report
4.2 Infrastructural setting		
4.2.1 Office space	IND./NAT.35. Average size (m^2) of office spaces, meeting spaces	EAS agency survey
	IND./NAT.36. Average number of main office furniture and equipment	EAS agency survey
	IND./NAT.37. Average number of meeting room furniture and equipment	EAS agency survey
4.2.2 Transportation vehicles	IND./NAT.38. Average number of travel vehicles	EAS agency survey
	IND./NAT.39. Ratio between travel vehicles and agents	EAS agency survey
4.2.3 Experiment and testing	IND./NAT.40. Average size (m^2) of fields for experiments and demonstration	EAS agency survey
	IND./NAT.41. Number and average size (m^2) of well-equipped labs	EAS agency survey
4.2.4 Training space	IND./NAT.42. Average size (m^2) of farmer training venues	EAS agency survey
	IND./NAT.43. Number of training facilities	EAS agency survey
4.3 Supporting policies		
	IND./NAT.44. Policy nature	Published national legal documents
	IND./NAT.45. Policy scope	Published national legal documents
5. Key outputs and outcomes		
5.1 Accessibility	IND./NAT.46. Percentage of farming households with access to public EAS on average	Farmer/farm survey
	IND./NAT.47. Percentage of farmers who received essential public EAS	Farmer/farm survey
	IND./NAT.48. Farmer-to-agent ratio	National statistics
5.2 Accountability	IND./NAT.49. Participatory M&E mechanism	EAS agency and farmer/farm survey
	IND./NAT.50. Participatory performance evaluation of public EAS agents	EAS agency and farmer/farm survey
	IND./NAT.51. Clear line of reporting and feedback system at all administrative levels of public EAS system	EAS agency survey
5.3 Affordability	IND./NAT.52. Average cost of public EAS per farmer	National statistics and EAS budget execution report
	IND./NAT.53. Average cost of public EAS per hectare of farms	National statistics and EAS budget execution report

Item	Indicators	Data sources
5.4 Adaptability	IND./NAT.54. Presence of demand-driven operational mechanism of public EAS	EAS agency survey
	IND./NAT.55. Percentage of farmers/farms that have accessed digital EAS	EAS agency survey
	IND./NAT.56. Percentage of farmers that have received digital literacy training	EAS agency survey
5.5 Achievements	IND./NAT.57. Agricultural labour productivity	National statistics
	IND./NAT.58. Agricultural land output rate	National statistics
	IND./NAT.59. Contribution rate of agricultural science and technology progress to agricultural GDP	National statistics
	IND./NAT.60. Per capita disposable income of farmers	National statistics
	IND./NAT.61. Comprehensive mechanization rate of crop cultivation and harvesting	National statistics
	IND./NAT.62. Water consumption per unit agricultural GDP	National statistics
	IND./NAT.63. Energy consumption per unit agricultural GDP	National statistics

Source: Authors' own elaboration.

Explanations for the indicators at the national level

IND./NAT.1. Percentage of townships or villages or farmer communities that are covered by public EAS is an indicator that tells the geographic coverage of the national public EAS system at the grassroots level. The percentage is derived by dividing the total number of townships or villages or farmer communities where farmers can access public EAS by the total number of townships or villages or farmer communities and multiplying by 100.

IND./NAT.2. Percentage of regions, districts or provinces that are covered by public EAS agencies is an indicator that tells the geographic coverage of the national public EAS system at the regional level. The percentage is derived by dividing the total number of regions, districts or provinces where farmers can access public EAS by the total number of regions, districts or provinces and multiplying by 100.

IND./NAT.3. Coverage of production-related public technical EAS based on farmers' needs checks whether the national public EAS system provides demand-driven services that cover agronomy, animal husbandry, aquaculture and agromachinery. This is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.4. Coverage of post-production public technical EAS based on farmers' needs checks whether the national public EAS system provides demand-driven services that cover ago-produce harvest and storage management, safety and quality testing and monitoring, processing and packaging, certification, marketing and so on. This is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.5. Management model indicates whether the national public EAS system is governed with a top-down approach or a decentralized one to decision-making in terms of funding, policymaking, staffing and so on. This is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.6. Total publicly funded budget as a percentage of agricultural GDP refers to the total national government budget on public EAS which is expressed as a percentage of the GDP from the agricultural sector at the national level. This information is derived by dividing the total national government budget for public EAS by the national agricultural GDP and multiply by 100. A higher percentage of agricultural GDP spent on public EAS shows a higher government priority for public EAS. When interpreting this indicator, one should be aware that due to EAS privatization, a higher proportion of the total budget for public EAS may be funded by the private sector in some countries, thus making public budget appear lower than in other countries.

IND./NAT.7. Publicly funded operation budget as a percentage of total public EAS budget refers to the total national government budget for operating the public EAS system and providing public technical EAS which is expressed as a percentage of the total public EAS budget at the national level. This information is derived by dividing national government-funded operation budget by the total public EAS budget at the national level and multiply by 100. A higher percentage of the total public EAS budget spent on providing public technical EAS shows a higher likelihood of a functioning public EAS system.

IND./NAT.8. Publicly funded staff budget as a total public EAS budget refers to the total national government budget for remunerating public EAS staff which is expressed as a percentage of the total public EAS budget at the national level. This information is derived by dividing national government-funded public EAS staff remuneration budget by the total public EAS budget at the national level and multiply by 100. A

higher percentage of the total public EAS budget spent on remunerating public EAS staff means that a smaller portion of the public EAS budget is spent on the provision of public technical EAS. This suggests a lower likelihood of a functioning public EAS system.

IND./NAT.9. Field trials and demonstration of new varieties, inputs, technologies, etc.: Field trial refers to the establishment of plots for experimentation where new agricultural varieties, inputs, technologies and so on are evaluated on the basis of various characteristics and properties. Field trials are often set up and performed in seed, plant protection or fertilization. Field demonstration refers to a long-term educational activity conducted in a systematic manner in farmers' fields to show the worth of new varieties, inputs, technologies, etc. This is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.10. Farmer training refers to all the educational activities provided by the national public EAS system that are aimed at improving farmers' technical and soft skills and knowledge. This is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.11. Technical extension and advisory services are all the different activities that provide the information, knowledge and services needed by farmers and other actors in rural/agricultural settings to assist them in developing their own technical skills (such as farm operation skills, crops and animals management skills, agromachinery operation skills, etc.) so as to improve their productive activities, production, and livelihoods. This is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.12. Technical policy advisory and advocacy: Policy advisory and advocacy have shown positive effects on the uptake of skills and knowledge, adaptation to new technology and productivity of rural communities. This is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.13. Technical support for agroproducts certification and marketing is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.14. Crop pest monitoring and forecasting means checking the crop fields and broader landscapes, forests or other sites to identify which pests are present, how many there are, or what damage they have caused or are causing. Correctly identifying the pest is key to knowing whether a pest is likely to become a problem and determining the best management strategy. Pest forecasting is the data-supported prediction of future activities of biotic agents, which would adversely affect crop production. The monitoring data on pest population or damage over a long period of time together with other variable factors, which affect the development of pest, may be useful for forecasting the pest incidence. This is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.15. Animal disease detection and diagnostics is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.16. Soil testing and monitoring is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.17. Soil moisture monitoring is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.18. Crop development monitoring is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.19. Agromachinery quality and safety testing is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.20. Meteorological service is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.21. Early warning of natural disaster is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.22. Safety and quality testing of agroproducts is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.23. Providing marketing information is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.24. Plant and animal quarantine: Plant quarantine is referred to as the legal enforcement of the measures aimed to prevent pests from spreading or to prevent them from multiplying further in case they have already gained entry and have established in new restricted areas (Ecofriendly Pest Management for Food Security, 2016). Animal quarantine means the keeping in isolation of animals which are to be introduced in a herd or territory for a definite period of time as a preventive measure against the spread of infectious diseases in a healthy population. This is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.25. Verification, registration, introduction of new varieties is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.26. Implementing one health laws or policies is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.27. Inputs quality testing and market supervision is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.28. Judicial detection and arbitration of production accidents is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed to check whether this technical service is provided by the national public EAS system. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./NAT.29. Agricultural technical specialists as a percentage of total public EAS staff is an indicator meant to reveal the human resource structure of the national public EAS system. This indicator offers a straightforward look at the technical capacities of the national public EAS system. The percentage is derived by dividing the total number of agricultural technical specialists (i.e. public EAS agents with a vocational diploma, or a Bachelor of Science degree, Master of Science degree or PhD degree in agriculture science) by the total number of public EAS staff and multiplying by 100. If the national statistical data are not available, this information can be collected by conducting a sample survey of public EAS agencies wherein the competent authorities are interviewed. The national-level data can be estimated by using this formula: Total number of agricultural technical specialists x 100 / total number of the public EAS staff from the surveyed public EAS agencies.

IND./NAT.30. Educational attainment of public EAS staff in agricultural science as a percentage of total public EAS staff is an indicator meant to reveal the average educational level of public EAS staff. This indicator offers a straightforward look at the technical capacities of public EAS staff. It is derived by dividing respectively the total number of public EAS staff with a vocational diploma, Bachelor of Science degree, Master of Science degree, and PhD degree in agriculture science by the total number of public EAS staff and multiplying by 100. If the national statistical data are not available, this information can be collected by conducting a sample survey of public EAS agencies wherein the competent authorities are interviewed. The national-level data can be estimated by using this formula: Total number of public EAS staff with an educational degree (vocational diploma, Bachelor of Science degree, Master of Science

degree, and PhD degree) in agricultural science x 100 / total number of the public EAS staff from the surveyed public EAS agencies.

IND./NAT.31. Average days of agricultural technical refresher or updating training received by each public EAS staff in one year is an indicator meant to reveal whether the national public EAS system provided adequate training on a continued basis. It is derived by dividing the total days of agricultural technical refresher or updating training received by public EAS staff in one year by the total number of public EAS staff. This information can be collected by conducting a sample survey of EAS agencies wherein the competent authorities are interviewed. The national-level data can be estimated by using this formula: Total days of agricultural technical refresher or updating training received by the public EAS staff from the surveyed public EAS agencies in one year / total number of the public EAS staff from the surveyed public EAS agencies.

IND./NAT.32. Number of public EAS agencies per million farmers is derived by dividing the total number of public EAS agencies by total number of farmers and multiplying by one million. A higher number indicates that the national public EAS system has a better geographical coverage and more farmers are likely to be served by the public EAS system.

IND./NAT.33. Number of public EAS agents per million farmers is derived by dividing the total number of public EAS agents by total number of farmers and multiplying by one million. A higher number indicates that more farmers are likely to be served by the public EAS system.

IND./NAT.34. Public expenditures on public EAS as a percentage of total agricultural GDP refers to the total national government spending on public EAS which is expressed as a percentage of the GDP from the agricultural sector at the national level. This information is derived by dividing total government spending for public EAS by the agricultural GDP and multiply by 100. A higher percentage of agricultural GDP spent on public EAS shows a higher government priority for public EAS. When interpreting this indicator, one should be aware that due to EAS privatization, a higher proportion of the total expenditures for public EAS may be funded by the private sector in some countries, thus making public expenditures appear lower than in other countries.

IND./NAT.35. Average size (m^2) of office spaces, meeting spaces is derived by dividing the total acreage of office spaces, meeting spaces by the total number of office spaces, meeting spaces available to public EAS agencies.

IND./NAT.36. Average number of main office furniture and equipment is derived by dividing the total number of furniture and equipment such as tables, chairs, computers and so on available in the offices of public EAS managers and agents by the total number of public EAS agencies.

IND./NAT.37. Average number of meeting room furniture and equipment is derived by dividing the total number of furniture and equipment such as tables, chairs, computers, projectors and so on available in the meeting rooms of public EAS agencies by the total number of meeting rooms of public EAS agencies.

IND./NAT.38. Average number of travel vehicles is derived by dividing the total number of travel vehicles such as motorbikes, bicycles, cars and so on by the total number of public EAS agencies.

IND./NAT.39. Ratio between travel vehicles and agents is an indicator meant to reveal whether the national public EAS system is supporting the mobility of public EAS agents in a way to guarantee the outreach of public EAS especially in remote areas away from the public EAS agency. The ratio is derived by dividing the total number of travel vehicles (including cars, motorbikes etc.) by the total number of public EAS agents. This information can be collected by conducting a sample survey of public EAS agencies wherein the competent authorities are interviewed. The national-level data can be estimated by using this formula: Total number of travel vehicles possessed by the surveyed public EAS agencies / total number of the public EAS agents from the surveyed public EAS agencies. A higher ratio means that the public EAS agents have a better mobility and thereby a better outreach than when the ratio is low.

IND./NAT.40. Average size (m^2) of fields for experiments and demonstration refers to the average acreage of fields for experiments and demonstration of new technologies and varieties. The average size is derived by dividing the total acreage of fields for experiments and demonstration by the total number of fields for experiments and demonstration.

IND./NAT.41. Number and average size (m^2) of well equipped labs refer to the number and average acreage of well equipped labs that public EAS agencies have to test seeds, pesticide residue, fertilizer or soil. The average size is derived by dividing the total acreage of well equipped labs by the total number of well equipped labs.

IND./NAT.42. Average size (m^2) farmer training venues[3] is derived by dividing the total acreage of farmer training venues (including training venues that do not belong to public EAS agencies but are at their disposal) in a country by the total number of farmer training venues in a country.

IND./NAT.43. Number of training facilities refers to the total number of farmer training facilities, such as computers, projectors, whiteboards, tables, chairs and so on that the sample public EAS agencies possess to conduct farmer training activities.

[3] Training venues are not necessarily to be of a public EAS agency's own. What is important is that that training venues are available for them to use when needed.

IND./NAT.44. Policy nature is a qualitative indicator. This information can be collected by conducting a sample survey of competent authorities of public EAS agencies. The policy nature can be assessed by answering these questions: Is it a national law or regulation? Is it an administrative circular or decree issued by the government? Is it an administrative document issued by the Ministry of Agriculture and Rural Affairs?

IND./NAT.45. Policy scope is a qualitative indicator. This information can be collected by conducting a sample survey of competent authorities of public EAS agencies. The policy scope can be assessed by answering these questions: Do the policies (national law or regulations or administrative documents) cover the mandates, financial mechanisms, infrastructural settings, human resource management, M&E systems and legal liabilities of the public EAS system?

IND./NAT.46. Percentage of farming households with access to public EAS is derived by dividing the number of farming households that accessed public EAS within a certain period of time by the total number of farming households and multiplying by 100. This information can be collected by conducting a sample farming households survey/interview and the percentage is extrapolated by using this formula: Number of farming households surveyed/interviewed that accessed public EAS x 100 / total number of farming households surveyed/interviewed.

IND./NAT.47. Percentage of farmers who received essential public EAS is derived by dividing the number of farmers who received essential public EAS by the total number of farmers and multiplying by 100. This information can be collected by conducting a sample farmer survey/ interview and the percentage is extrapolated by using this formula: Number of farmers surveyed/interviewed who received essential public EAS x 100 / total number of farmers surveyed/interviewed.

IND./NAT.48. Farmer-to-agent ratio is a commonly used measure designed to illustrate the number of clients each EAS agent is expected to serve. The ratio is calculated by determining the total potential clients within a geographic area (district, region, nation) and dividing this figure by the total number of agents responsible for this area, scaled to a denominator of one. While high ratios suggest understaffing and perhaps a high degree of unserved potential clients, recommendations for an ideal ratio are mixed and depend largely on the context and services provided (Swanson, Bentz and Sofranko, 1997).

IND./NAT.49. Participatory M&E mechanism is a qualitative indicator. This information can be collected by conducting a sample survey of competent authorities of public EAS agencies and farmers who have accessed public EAS. The interviewees are required to describe the M&E mechanism of the public EAS provided and inform whether and how farmers were involved in the process. On this basis, an assessment can be made.

IND./NAT.50. Participatory performance evaluation of public EAS agents is a qualitative indicator. This information can be collected by conducting a sample survey of competent authorities of public EAS agencies and farmers who have accessed public EAS. The interviewees are required to describe the performance evaluation of public EAS agents and inform whether and how farmers were involved in the process. On this basis, an assessment can be made.

IND./NAT.51. Line of reporting and feedback system at all administrative levels of public EAS system is a qualitative indicator. This information can be collected by conducting a sample survey of competent authorities of public EAS agencies. The interviewees are required to describe the line of reporting and feedback system within the surveyed public EAS agencies. On this basis, an assessment can be made.

IND./NAT.52. Average cost of public EAS per farmer is derived by dividing the total cost of public EAS and total number of farmers.

IND./NAT.53. Average cost of public EAS per hectare of farms is derived by dividing the total cost of public EAS and total acreage of farms.

IND./NAT.54. Presence of demand-driven operational mechanism of public EAS is a qualitative indicator. This information can be collected by conducting a sample survey of competent authorities of public EAS agencies. The interviewees are required to describe the operational mechanism of the public EAS provided and inform whether and how farmers' demands were taken into account in the process. On this basis, an assessment can be made.

IND./NAT.55. Percentage of farmers/farms that have accessed digital EAS: Digital agricultural EAS are services in the form of agricultural information or knowledge that are delivered to clients (e.g. farmers) via digital tools such as phone calls, WhatsApp groups and specialized smartphone applications used for agricultural knowledge brokering and so on (Coggins *et al*., 2022). The percentage is derived by dividing the total number of farmers/farms that have accessed digital EAS by the total number of farmers/farms and multiplying by 100. This information can be collected by conducting a sample farmer survey/interview and the percentage is extrapolated by using this formula: Total number of farmers/farms surveyed/interviewed that have accessed digital EAS x 100 / total number of farmers/farms surveyed/interviewed.

IND./NAT.56. Percentage of farmers that have received digital literacy training is derived by dividing the number of farmers who have attended training that is provided by public EAS agencies and aimed at improving their digital skills to use digital tools to access digital EAS within a certain period of time by the total number of farmers and multiplying by 100. This information can be collected by conducting a sample survey/interview of farmers. The percentage is extrapolated by using this formula: Number

of farmers who have attended digital literacy training within a certain period of time x 100 / total number of farmers.

IND./NAT.57. Agricultural labour productivity refers to the added value of agriculture, forestry, animal husbandry and fishery created by each agricultural labour force. Calculation formula: Per capita added value of agriculture, forestry, animal husbandry and fishery = Added value of agriculture, forestry, animal husbandry and fishery / number of employed persons in the primary industry.

IND./NAT.58. Agricultural land output rate is indicated by the added value of agriculture, forestry, animal husbandry and fishery of per unit area of arable land. Calculation formula: The added value of agriculture, forestry, animal husbandry and fishery of per unit area of arable land = The added value of agriculture, forestry, animal husbandry and fishery / Arable land area.

IND./NAT.59. Contribution rate of agricultural science and technology progress refers to the balance after deducting the growth rate of the total output value generated by the new inputs from the growth rate of the total agricultural output value.

IND./NAT.60. Per capita disposable income of farmers refers to the average disposable income of rural households by population (that is, the total net income obtained by rural households from various sources in the year after deducting the expenses incurred accordingly), which is a core indicator for measuring the living standards of rural residents.

IND./NAT.61. Comprehensive mechanization rate of crop cultivation and harvesting is an important indicator reflecting the development level of agricultural mechanization. It refers to the comprehensive operation level of various crops, including mechanized tillage, sowing (planting) and harvesting. The rate is calculated according to the weighted sum of the weights of mechanized tillage, sowing (planting) and harvesting respectively accounting for 40 percent, 30 percent and 30 percent. Calculation formula: Comprehensive mechanization rate of crop cultivation and harvesting = Mechanized tillage rate x 40% + Mechanized sowing (planting) rate x 30% + Mechanized harvesting rate x 30%. Among them, the mechanized tillage rate refers to the mechanized tillage area as a percentage of the sown area of various crops that should be tilled. The tillable area in the sown area of crops is equal to the sown area of crops minus the sown area of no-tillage. The mechanized sowing (planting) rate refers to the area of mechanized planting as a percentage of the total sown area of various crops. The mechanized harvesting rate refers to the machine-harvested area as a percentage of the total harvested area of various crops.

IND./NAT. 62. Water consumption per unit agricultural GDP refers to the ratio of agricultural water consumption to the added value of

agriculture, forestry, animal husbandry and fishery. It is an important indicator reflecting the level of ecological protection.

IND./NAT.63. Energy consumption per unit agricultural GDP refers to the ratio of total energy consumption to the added value of agriculture, forestry, animal husbandry and fishery. Calculation formula: Energy consumption per unit agricultural GDP = Total energy consumption / Added value of agriculture, forestry, animal husbandry and fishery. Among them, the total energy consumption refers to the energy consumption in the whole process of agricultural production. The calculation formula is: Total energy consumption = Physical energy consumption of agriculture, forestry, animal husbandry and fishery x Reference coefficient of energy converted to standard coal.

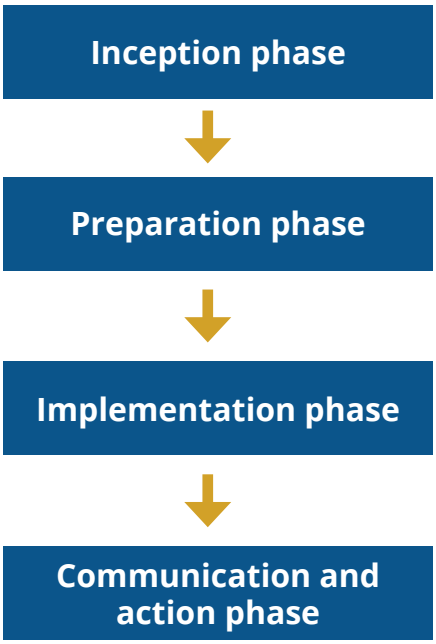
IND./NAT.64. Ratio of public agricultural R&D spending to agricultural GDP is the ratio of agricultural research investment over agricultural output, the so-called "agricultural research intensity ratio (ARI)"[4]. The formulation to calculate the ratio is AgRE / AgGDP, namely, the numerator "agricultural research expenditure" divided by the denominator "agricultural gross domestic product" (Beintema and Elliott, 2009).

5.4 Operational framework

An overview of the operational framework of the M&E of the public EAS system at the national level is presented in Figure 2. It consists of four interlinked phases, including inception, preparation, implementation, and communication. There are specific activities in each phase. The operational framework should be tailored and adapted to the specific M&E situation of a certain country. This is meant to meet the objectives as well as to take into consideration the capacities, resources available, and time needed to effectively conduct the M&E. The M&E process of the public EAS system is a reflective learning cycle, which consists of a number of reflection and refinement workshops as well as capacity development events.

[4] An ARI of one percent has been seen by many as a target that low income agriculturally-based countries should strive for. However, the ARI by itself is influenced by several factors that need to be studied in depth at the country level. The ARI can be decomposed into an identity with four components: (1) priority to research within agricultural expenditure; (2) priority to agriculture in total public expenditure; (3) fiscal capacity measured as the ratio of public expenditure to gross domestic product (GDP); and (4) the (inverse of the) share of agriculture in the GDP (Beintema and Elliott, 2009).

FIGURE 2. **M&E operational framework of the public EAS system at the national level**



Source: Authors' own elaboration.

5.4.1 Inception phase

The main objectives of the inception phase are to initiate the process, stimulate commitment, and gain support of the key stakeholders. The following activities are suggested for this phase:

- establishing an M&E steering committee which consists of key stakeholders of the public EAS system;
- setting up a team composed of management specialists within the public EAS system or assigned by the public EAS management to be in charge of the M&E;
- developing the terms of references (ToRs) for the M&E team, defining the rationale of the M&E with specific objectives, clarifying expectations, agreeing on the common vision, and identifying entry points for the M&E;
- mapping actors and characterizing the boundary of the public EAS system and performing stock analysis of its key challenges, opportunities, and constraints;
- carrying out an inception workshop to define the M&E scope and key questions from the perspective of public EAS stakeholders; and
- conducting necessary training activities or courses to build the capacities of the M&E team.

5.4.2 Preparation phase

The preparation phase is an integral part of the capacity development process targeted at supporting actors who will form the M&E team. The objectives of the preparation phase are to (1) design an M&E work plan that meets expectations and makes efficient use of financial and human resources, (2) help the M&E team review and re-assess the expectations against the M&E framework, and (3) support the M&E team to get familiarized with the M&E methodology, process, and approaches. The following activities can be carried out:

- organizing team meetings to review and re-analyse the expected outputs of the M&E;
- reviewing and identifying the boundaries of the public EAS system and main entry points for the M&E;
- identifying and selecting the key indicators from the indicator framework (Table 3) for M&E in accordance with country-specific situations;
- selecting appropriate data collection tools and methods (qualitative and quantitative) and preparing necessary questionnaires, metrics or tables;
- identifying the key stakeholders of the public EAS system, informants and organizations to be involved in the M&E; and
- developing a work plan on the M&E of the public EAS system in details by taking stock of available human and financial resources.

5.4.3 Implementation phase

This phase consists of interconnected activities as follows:

- carrying out desk work to collect, review and analyse secondary data and information;
- collecting data, using the approach and tools against the indicators selected in Phase 2;
- interviewing key public EAS stakeholders. Some data tend to be difficult to get (missing even at the national level) based on the desk study and normal data collection methods. Therefore, a series of semi-structured interviews are to be conducted with key stakeholders. Telephone or video interviews and limited face-to-face interviews will be held with the selected stakeholders when online approaches are considered less feasible. The following stakeholder will be included in the interviews:
  - public EAS agents, including those working at the grassroots, regional and national levels. The main goal is to complement the desk work to get the missing data or clarify the confusing information;
  - non-public EAS providers (optional), including researchers, farmer organizations, NGOs (community facilitators, knowledge facilitators), private agribusinesses (market intermediaries), etc. to gain an insight

into their experience with and reflections on the public EAS system;
- policy and regulatory representatives, including legislators or policy-makers at the grassroots, regional and national levels and relevant officers in government extension and regulatory departments. They are generally in charge of regulating EAS quality and provision. Interviews may focus on how they view the existing public EAS system, the functions of licensed or authorized law enforcement of technical agricultural EAS (such as quality and market supervisions for agricultural inputs including seeds, fertilizers and pesticides, etc.), and existing gaps;
- smallholder farmers: In each country, sample smallholder farmers are to be interviewed to assess their experience with and reflections on the following aspects of the public EAS system in terms of the efficiency, effectiveness and relevance of the public EAS delivered. Interviews will mainly seek information on the accessibility, affordability, adaptability, and accountability of public EAS;

- analyzing and interpreting the collected data, and formulating a preliminary M&E report with policy recommendations;
- organizing mini-workshops for reflection and learning for the consolidation of the preliminary M&E report with policy recommendations; and
- sharing the consolidated M&E report with policy recommendations and seeking feedback from key public EAS stakeholders.

5.4.4 Communication and action phase

In this phase, the M&E results of the public EAS system in the form of an M&E report are to be thoroughly and widely discussed with EAS managers, policy decision-makers and wider groups of EAS stakeholders. Based on the discussions, the M&E report with policy recommendations is to be validated and communicated to the key EAS stakeholders. The validation and communication of the M&E results is not a once-off activity; rather, it is a continuous part of the M&E. This phase consists of a series of proposed activities as follows:

- organizing a participatory and multistakeholder validation workshop;
- finalizing the M&E report with inputs, comments and suggestions collected during the validation workshop;
- organizing EAS management and policy dialogue events;
- communicating and disseminating the validated M&E report with policy recommendations to the key EAS stakeholders; and
- developing, validating and implementing action plans to reform and strengthen public EAS systems if necessary in accordance with the M&E results and policy recommendations.

6. Monitoring and evaluation module at the grassroots level

6.1 Introduction

The performance of the public EAS system at the grassroots (township, village or equivalent) level is critical to maintain the effectiveness and functionality of the national public EAS system. Therefore, it is of great importance for the public EAS system to develop and implement a self-M&E system at the grassroots level. This will pave the way for strengthening the public EAS system in terms of ensuring service quality and promoting effectiveness and efficiency of services. With this in mind, this M&E module at the grassroots level is developed and proposed for the public EAS agencies and agents to use for self-M&E. This module proves important for three reasons:

- First, **at the management level:** Public EAS agencies need to properly monitor and evaluate the performance of grassroots public EAS stations in terms of relevance, efficiency and effectiveness of services.
- Second, **at the operational level:** Self-M&E should be considered as an integral part of the public EAS system. The public EAS system's self-M&E at the grassroots level is crucial for ensuring the relevance and quality of the public services delivered to farmers. This module complements the module at the national level and provides a straightforward method to assess the performance of grassroots public EAS systems. In doing this, it helps improve their operational effectiveness and efficiency.
- Third, **at the client level:** This module can assist farmers or farmer organizations to feedback their needs to help improve public EAS. In order to strengthen service provision and increase impacts, local public EAS agencies or agents should identify capacity needs and gaps in service delivery based on the feedback from EAS clients including farmers.

6.2 Key monitoring and evaluation elements

To develop and implement an effective M&E module at the grassroots level, the ToC mentioned in Part 3 serves as a useful basis. Accordingly, EAS-related inputs, activities as well as outputs and outcomes are the key M&E elements.

Outcomes: Outcomes, referred to as changes induced by the access to and deployment of public EAS by clients, can be assessed by changes in knowledge, awareness, attitudes, behaviour, practices and/or capacities depending on the focus of services provided (Sulaiman V *et al*., 2022a). The outcome indicators may cover the aspects of the adoption of new knowledge and technologies, productivity, uptake of technical services and so on.

Outputs: Outputs are the immediate results in terms of clients' access to public EAS following the activities of service delivery. EAS can generate the expected changes only if they are made accessible to all clients who demand them (ibid.). It is therefore very important to ensure that EAS are made available, accessible physically, and affordable (as public goods to smallholder farmers) to the majority of people who require them (ibid.). The output indicators can include (1) percentage and characteristics of EAS clients (including women, youth and other vulnerable farmers) who accessed the services, (2) geographical coverage of the services, and (3) degree of organization of EAS clients' (such as share of farmers or producers organized into farmers cooperatives or producers organizations, etc.) (ibid.).

Activities: Activities refer to actions or work carried out by EAS agents to supply various services corresponding to users' needs (ibid.). Broadly speaking, there are five main categories of EAS activities at the grass-roots level, namely (1) test and demonstration of new animal and plant varieties, new animal and plant resources, new agricultural machinery, and new inputs (e.g. pesticides, chemical fertilizers); (2) monitoring services, including disease and pests monitoring, agricultural monitoring (e.g. crop growth, seedling condition, soil moisture), natural disasters (e.g. drought, flood) monitoring, and agricultural product supply and demand monitoring; (3) testing and inspection, such as animal and plant quarantine, agricultural product quality and safety testing (such as pesticide residues), and inputs (seeds, pesticides, and chemical fertilizers) quality testing; (4) resource management, such as the management of soil, animal and plant resources, water resources, pasture and so on; and (5) farmer training, including normative training, farmer field schools (FFS), digital training and so on.

Inputs: Inputs refer to the elements that are directly mobilized or that affect the planning and implementation of EAS interventions (ibid.). The input indicators can cover the aspects of capacity, financial resources, infrastructure and so on.

6.3. Indicator frameworks

73 indicators were selected for the M&E module at the grassroots level, covering four categories of indicators, namely, inputs (11 indicators), activities (37 indicators), outputs (nine indicators) and outcomes (16 indicators). The selection of indicators for this module was guided by the main M&E objective of the grassroots public EAS system, that is, to help maintain the functionality and effectiveness of the system to guarantee essential public EAS to clients, particularly smallholder farmers. Therefore, the proposed indicators all focus on the contributing factors of the performance of the grassroots public EAS system as well as the main results. Table 4 below provides the structure of the indicator framework and commonly used indicators for reference. Specific indicators are to be defined and applied in accordance with local situations and conditions. Therefore, it is worth noting that the proposed indicator framework, when applied, must be adjusted and adapted in line with the local requirements and specific context.

TABLE 4. **Indicator frameworks of the public extension and advisory service system's monitoring and evaluation at the grassroots level**

Item	Indicators	Data sources
1. Outcomes		
1.1 Agronomy	IND./GR.1. Adoption rate of new crop varieties by farmers/farms	Farmer/farm survey or EAS agency survey or local government statistics
	IND./GR.2. Quantity of crops produced	Farmer/farm survey or EAS agency survey or local government statistics
	IND./GR.3. Adoption rate of balanced fertilization by farmers/farms	Farmer/farm survey or EAS agency survey or local government statistics
	IND./GR.4. Adoption rate of integrated pest management technologies by farmers/farms	Farmer/farm survey or EAS agency survey or local government statistics
	IND./GR.5. Adoption rate of advanced spraying facilities	Farmer/farm survey or EAS agency survey or local government statistics
	IND./GR.6. Adoption rate of new cultivation technologies	Farmer/farm survey or EAS agency survey or local government statistics
1.2 Animal husbandry	IND./GR.7. Quantity of meat produced	Farmer/farm survey or EAS agency survey or local government statistics
	IND./GR.8. Quantity of animal feed produced	Farmer/farm survey or EAS agency survey or local government statistics
	IND./GR.9. Quantity of diary products	Farmer/farm survey or EAS agency survey or local government statistics
	IND./GR.10. Quantity of manure collected, processed and reused as fertilizers	Farmer/farm survey or EAS agency survey or local government statistics

Item	Indicators	Data sources
1.3 Aquaculture	IND./GR.11. Quantity of aquatic products	Farmer/farm survey or EAS agency survey or local government statistics
	IND./GR.12. Adoption rate of AI-driven smart aquatic fish farming	Farmer/farm survey or EAS agency survey or local government statistics
	IND./GR.13. Adoption rate of new aquaponic technologies	Farmer/farm survey or EAS agency survey or local government statistics
1.4 Agro-machinery	IND./GR.14. Comprehensive mechanization rate of crop cultivation and harvesting	Farmer/farm survey or EAS agency survey or local government statistics
	IND./GR.15. Percentage of farmers/farms that have received testing and safety certification of their agro-machinery	Farmer/farm survey or EAS agency survey or local government statistics
1.5 Digital EAS	IND./GR.16. Percentage of farmers/farms that have accessed digital EAS	Farmer/farm survey or EAS agency survey or local government statistics
1.6 Skills	IND./GR.17. Percentage of farmers who have improved their technical skills after having received the public EAS	Farmer/farm survey
	IND./GR.18. Percentage of farmers who have improved their entrepreneurial skills after having received the public EAS	Farmer/farm survey
	IND./GR.19. Percentage of farmers who have improved their soft skills after having received the public EAS	Farmer/farm survey
	IND./GR.20. Percentage of farmers who have improved their digital literacy after having received the public EAS	Farmer/farm survey
2. Outputs		
	IND./GR.21. Percentage of farmers/farms that have accessed public EAS	Farmer/farm survey or EAS agency survey/statistics
	IND./GR.22. Percentage of women/young farmers accessing public EAS	Farmer/farm survey or EAS agency survey/statistics
	IND./GR.23. Percentage of territories covered by public EAS	EAS agency survey/statistics
	IND./GR.24. Percentage of smallholder farmers organized in cooperatives/associations	Farmer/farm survey
	IND./GR.25. Percentage of women/young farmers organized in cooperatives/associations	Farmer/farm survey

Item	Indicators	Data sources
3. Activities		
3.1 Introduction, field trial and demonstration	IND./GR.26. Number of new crop varieties introduced, experimented and demonstrated	Farmer/farm survey or EAS agency survey/statistics
	IND./GR.27. Number of new inputs introduced, experimented and demonstrated	Farmer/farm survey or EAS agency survey/statistics
	IND./GR.28. Number of new cultivation technologies introduced, experimented and demonstrated	Farmer/farm survey or EAS agency survey/statistics
	IND./GR.29. Number of field trials and demonstrations of water saving and rain-fed agriculture technologies	Farmer/farm survey or EAS agency survey/statistics
	IND./GR.30. Number of field trials and demonstrations of integrated pest management technologies	Farmer/farm survey or EAS agency survey/statistics
	IND./GR.31. Number of field trials and demonstrations of agroecological management technologies	Farmer/farm survey or EAS agency survey/statistics
	IND./GR.32. Number of experiments and demonstrations of polyculture ponds	Farmer/farm survey or EAS agency survey/statistics
	IND./GR.33. Number of experiments and demonstrations of fish disease control technologies	Farmer/farm survey or EAS agency survey/statistics
	IND./GR.34. Number of experiments and demonstrations of agrifood products processing technologies	Farmer/farm survey or EAS agency survey/statistics
	IND./GR.35. Number of experiments and demonstrations of aquaponics technologies	Farmer/farm survey or EAS agency survey/statistics
	IND./GR.36. Number of experiments and demonstrations of agromachinery for land preparing, harvesting and processing, etc.	Farmer/farm survey or EAS agency survey/statistics
	IND./GR.37. Number of experiments and demonstrations of agricultural drones and robotics technologies	Farmer/farm survey or EAS agency survey/statistics
3.2 Monitoring services		
3.2.1 Disease and pests monitoring	IND./GR.38. Percentage of farmers who have received crop pest monitoring service	Farmer/farm survey
	IND./GR.39. Percentage of herders who have received pasture and grassland pest monitoring service	Farmer/farm survey
	IND./GR.40. Percentage of livestock farmers who have received animal disease monitoring service	Farmer/farm survey
	IND./GR.41. Percentage of farmers who have received fish disease monitoring service	Farmer/farm survey

Item	Indicators	Data sources
3.2.2 Agricultural monitoring	IND./GR.42. Percentage of farmers who have received crop growth monitoring service	Farmer/farm survey
	IND./GR.43. Percentage of farmers who have received soil moisture monitoring service	Farmer/farm survey
	IND./GR.44. Percentage of herders who have received pasture and grassland monitoring service	Farmer/farm survey
	IND./GR.45. Animal breeding environment monitoring	EAS agency survey
	IND./GR.46. Fish breeding environment monitoring	EAS agency survey
	IND./GR.47. Natural fishery resources monitoring	EAS agency survey
3.2.3 Natural disasters monitoring	IND./GR.48. Percentage of farmers who have received drought warning service	Farmer/farm survey
	IND./GR.49. Percentage of farmers who have received flood monitoring warning service	Farmer/farm survey
3.3 Testing and inspection	IND./GR.50. Plant quarantine	EAS agency survey
	IND./GR.51. Animal quarantine	EAS agency survey
	IND./GR.52. Number of agricultural inputs quality testing	EAS agency survey
	IND./GR.53. Number of agricultural products quality and safety testing	EAS agency survey
	IND./GR.54. Number of quality certification of animal products	EAS agency survey
3.4 Resource management	IND./GR.55. Number of crop and plant varieties verified, registered, introduced and extended	EAS agency survey
	IND./GR.56. Number of livestock and poultry varieties verified, registered, introduced and extended	EAS agency survey
	IND./GR.57. Number of fish varieties verified, registered, introduced and extended	EAS agency survey
3.5 Farmer training	IND./GR.58. Percentage of farmers attending agronomic training	Farmer/farm survey or EAS agency survey/statistics
	IND./GR.59. Percentage of farmers attending livestock training	Farmer/farm survey or EAS agency survey/statistics
	IND./GR.60. Percentage of farmers attending fish farming training	Farmer/farm survey or EAS agency survey/statistics
	IND./GR.61. Percentage of farmers attending agromachinery operation training	Farmer/farm survey or EAS agency survey/statistics
	IND./GR.62. Percentage of farmers attending digital literacy training	Farmer/farm survey or EAS agency survey/statistics

Item	Indicators	Data sources
	4. Inputs	
	IND./GR.63. Number of agencies	EAS agency survey/statistics or local government statistics
	IND./GR.64. Number of public EAS agents	EAS agency survey/statistics or local government statistics
	IND./GR.65. Farmer-to-agent ratio	EAS agency survey/statistics or local government statistics
	IND./GR.66. Public expenditures on public EAS	EAS budget execution report
	IND./GR.67. Public expenditures on public EAS as a percentage of total agricultural GDP	EAS budget execution report
	IND./GR.68. Number and size (m^2) of office spaces	EAS agency survey
	IND./GR.69. Number of travel vehicles	EAS agency survey
	IND./GR.70. Size (m^2) of fields for experiments and demonstration of new technologies and varieties	EAS agency survey
	IND./GR.71. Number and size (m^2) of well-equipped labs	EAS agency survey
	IND./GR.72. Size (m^2) of farmer training venues	EAS agency survey
	IND./GR.73. Number of training facilities	EAS agency survey

Source: Authors' own elaboration.

Explanations for the indicators at the grassroots level:

IND./GR.1. Adoption rate[5] of new crop varieties by farmers/farms refers to the pace at which new crop varieties are adopted and cultivated for intensification by farmers. This rate can be represented by the percentage of farmers who start adopting a new crop variety during a specific period of time. It is often calculated by using this formula: Number of farmers who are cultivating the new crop variety x 100 / total number of farmers. The derived number is the percentage of the farmers who are cultivating the new crop variety to all farmers.

IND./GR.2. Quantity of crops produced is the sum of crop commodities produced such as cereals, vegetables, fruits and so on (after deductions of quantities used as seed and feed) in a certain period of time. It is measured in tonnes or thousand tonnes.

IND./GR.3. Adoption rate of balanced fertilization by farmers/farms: Balanced fertilization refers to the application of plant

[5] The adoption rate is part of the diffusion of innovations theory. That theory seeks to explain how the use of new technologies, processes, and innovations spread through a society, and why they are adopted over old methods.

nutrients in optimum ratio and adequate amounts. It is the proper supply of all nutrients (macros and micros) throughout the growth of a crop. The adoption rate of balanced fertilization by farmers/farms is calculated using this formula: Number of farmers who applied balanced fertilization during a specific period of time x 100 / total number of farmers. The derived number is the percentage of the farmers who applied balanced fertilization to all farmers.

IND./GR.4. Adoption rate of integrated pest management technologies by farmers/farms: According to the FAO, integrated pest management (IPM) means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agroecosystems and encourages natural pest control mechanisms. The adoption rate of IPM is calculated using this formula: Number of farmers who applied IPM during a specific period of time x 100 / total number of farmers. The derived number is the percentage of the farmers who applied IPM to all farmers.

IND./GR.5. Adoption rate of advanced spraying facilities: Advanced spraying facilities are machinery for efficient application of pesticides to crops. The adoption rate of advanced spraying facilities is calculated using this formula: Number of farmers who used advanced spraying facilities during a specific period of time x 100 / total number of farmers. The derived number is the percentage of the farmers who used advanced spraying facilities to all farmers.

IND./GR.6. Adoption rate of new cultivation technologies is calculated using this formula: Number of farmers who used new cultivation technologies (such as tillage free practices, regenerative agriculture, ecological agriculture, etc.) during a specific period of time x 100 / total number of farmers. The derived number is the percentage of the farmers who used new cultivation technologies to all farmers.

IND./GR.7. Quantity of meat produced is the sum of meat commodities produced such as pork, beef, mutton, poultry, etc. and so on (after deductions of quantities used as breeding animals) in a certain period of time. It is measured in tonnes or thousand tonnes.

IND./GR.8. Quantity of animal feed produced is the sum of animal feed produced such as hay, straw, silage, compressed and pelleted feeds and so on in a certain period of time. It is measured in tonnes or thousand tonnes.

IND./GR.9. Quantity of diary products is the sum of diary products produced such as raw milk, cheese, yogurt and so on in a certain period of time. It is measured in tonnes or thousand tonnes.

IND./GR.10. Quantity of manure collected, processed and reused as fertilizers is the sum of manure collected, processed and reused as fertilizers in a certain period of time. It is measured in tonnes or thousand tonnes.

IND./GR.11. Quantity of aquatic products is the sum of aquatic products produced such as fish, crabs, shrimps, shellfish and so on in a certain period of time. It is measured in tonnes or thousand tonnes.

IND./GR.12. Adoption rate of AI-driven smart aquatic fish farming: AI-driven smart aquatic fish farming is a smart production wherein fish farming activities can be controlled in a distance and automation by applying artificial intelligence, big data, 5G, IoT (Internet of things), cloud computing, and robotics. The adoption rate of AI-driven smart aquatic fish farming by fish farmers/farms is calculated using this formula: Number of fish farmers who used AI-driven smart aquatic fish farming technologies during a specific period of time x 100 / total number of fish farmers. The derived number is the percentage of the fish farmers who used used AI-driven smart aquatic fish farming technologies to all fish farmers.

IND./GR.13. Adoption rate of new aquaponic technologies is calculated using this formula: Number of practitioners who used new aquaponic technologies for crop, fish or vegetables production within a certain period of time during a specific period of time x 100 / total number of practitioners. The derived number is the percentage of practitioners who used new aquaponic technologies to all practitioners.

IND./GR.14. Comprehensive mechanization rate of crop cultivation and harvesting is an important indicator reflecting the development level of agricultural mechanization. It refers to the comprehensive operation level of various crops, including mechanized tillage, sowing (planting) and harvesting. The rate is calculated according to the weighted sum of the weights of mechanized tillage, sowing (planting) and harvesting respectively accounting for 40 percent, 30 percent and 30 percent. Calculation formula: Comprehensive mechanization rate of crop cultivation and harvesting = Mechanized tillage rate x 40% + Mechanized sowing (planting) rate x 30% + Mechanized harvesting rate x 30%. Among them, the mechanized tillage rate refers to the mechanized tillage area as a percentage of the sown area of various crops that should be tilled. The tillable area in the sown area of crops is equal to the sown area of crops minus

the sown area of no-tillage. The mechanized sowing (planting) rate refers to the area of mechanized planting as a percentage of the total sown area of various crops. The mechanized harvesting rate refers to the machine-harvested area as a percentage of the total harvested area of various crops.

IND./GR.15. Percentage of farmers/farms that have received testing and safety certification of their agromachinery is derived by dividing the number of farmers/farms that have received testing and safety certification of their agromachinery during a specific period of time by the total number of farmers/farms and multiplying by 100. This information can be collected by conducting a sample farmer survey/interview and the percentage is extrapolated by using this formula: Number of farmers/farms surveyed/interviewed that have received testing and safety certification of their agro-machinery during a specific period of time x 100 / total number of farmers/farms surveyed/interviewed.

IND./GR.16. Percentage of farmers/farms that have accessed digital EAS: Digital agricultural EAS are services in the form of agricultural information or knowledge that are delivered to clients (e.g. farmers) via digital tools such as phone calls, WhatsApp groups and specialized smartphone applications used for agricultural knowledge brokering and so on (Coggins *et al*., 2022). The percentage is derived by dividing the number of farmers/farms that have accessed digital EAS during a specific period of time by the total number of farmers/farms and multiplying by 100. This information can be collected by conducting a farmer sample survey/interview and the percentage is extrapolated by using this formula: Number of farmers/farms surveyed/interviewed that have accessed digital EAS during a specific period of time x 100 / total number of farmers/farms surveyed/interviewed.

IND./GR.17. Percentage of farmers who have improved their technical skills after having received the public EAS is derived by dividing the number of farmers that have improved their technical skills after having received the public EAS by the total number of farmers who have received the public EAS and multiplying by 100. This information can be collected by conducting a sample survey/interview of farmers who have accessed the public EAS during a certain period of time, in which they will participate in a test to assess their technical knowledge and skills. The percentage is extrapolated by using this formula: Number of farmers surveyed/interviewed whose score passes the borderline (i.e. test score is used as a proxy of technical skills improvement after having received the public EAS) x 100 / total number of farmers who have received the public EAS.

IND./GR.18. Percentage of farmers who have improved their entrepreneurial skills after having received the public EAS is derived by dividing the number of farmers that have improved their entrepreneurial skills after having received the public EAS by the total number of farmers who have received the public EAS and multiplying by 100. This information can be collected by conducting a sample survey/interview of farmers who have accessed the public EAS during a certain period of time, in which they will participate in a test to assess their entrepreneurial knowledge and skills. The percentage is extrapolated by using this formula: Number of farmers surveyed/interviewed whose score passes the borderline (i.e. test score is used as a proxy of entrepreneurial skills improvement after having received the public EAS) x 100 / total number of farmers who have received the public EAS.

IND./GR.19. Percentage of farmers who have improved their soft skills after having received the public EAS is derived by dividing the number of farmers that have improved their soft skills (such as communication, collaboration, problem-solving, etc.) after having received the public EAS by the total number of farmers who have received the public EAS and multiplying by 100. This information can be collected by conducting a sample survey/interview of farmers who have accessed the public EAS during a certain period of time, in which they will participate in a test to assess their soft skills. The percentage is extrapolated by using this formula: Number of farmers surveyed/interviewed whose score passes the borderline (i.e. test score is used as a proxy of soft skills improvement after having received the public EAS) x 100 / total number of farmers who have received the public EAS.

IND./GR.20. Percentage of farmers who have improved their digital literacy after having received the public EAS is derived by dividing the number of farmers that have improved their digital literacy (use of digital tools for accessing digital EAS) after having received the public EAS by the total number of farmers who have received the public EAS and multiplying by 100. This information can be collected by conducting a sample survey/interview of farmers who have accessed the public EAS during a certain period of time, in which they will participate in a test to assess their digital literacy. The percentage is extrapolated by using this formula: Number of farmers surveyed/interviewed whose score passes the borderline (i.e. test score is used as a proxy of digital literacy improvement after having received the public EAS) x 100 / total number of farmers who have received the public EAS.

IND./GR.21. Percentage of farmers/farms that have accessed public EAS is derived by dividing the number of farmers/farms that have accessed public EAS during a specific period of time by the total

number of farmers/farms and multiplying by 100. This information can be collected by conducting a farmer sample survey/interview and the percentage is extrapolated by using this formula: Number of farmers/farms surveyed/interviewed that have accessed public EAS during a specific period of time x 100 / total number of farmers/farms surveyed/interviewed.

IND./GR.22. Percentage of women/young farmers accessing public EAS is derived by dividing the number of women/young farmers that have accessed public EAS during a specific period of time by the total number of farmers and multiplying by 100. This information can be collected by conducting a farmer sample survey/interview and the percentage is extrapolated by using this formula: Number of women/young farmers surveyed/interviewed that have accessed public EAS during a specific period of time x 100 / total number of farmers/farms surveyed/interviewed.

IND./GR.23. Percentage of territories covered by public EAS is derived by dividing the number of subregional (county, township, village) administrative divisions that have public EAS agencies by the total number of subnational (regional and subregional) administrative divisions and multiplying by 100.

IND./GR.24. Percentage of smallholder farmers organized in cooperatives/associations is derived by dividing the number of smallholder farmers organized in cooperatives/associations by the total number of farmers and multiplying by 100.

IND./GR.25. Percentage of women/young farmers organized in cooperatives/associations is derived by dividing the number of women/young farmers organized in cooperatives/associations by the total number of farmers and multiplying by 100.

IND./GR.26. Number of new crop varieties introduced, experimented and demonstrated is the total number of new crop (such as cereal, fruits, vegetables, etc.) varieties that were introduced, experimented and demonstrated in a period of time by the public EAS agency.

IND./GR.27. Number of new inputs introduced, experimented and demonstrated is the total number of new agricultural inputs (such as seeds, fertilizers, pesticides, etc.) that were introduced, experimented and demonstrated in a period of time by the public EAS agency.

IND./GR.28. Number of new cultivation technologies introduced, experimented and demonstrated is the total number of new cultivation technologies that were introduced, experimented and demonstrated in a period of time by the public EAS agency.

IND./GR.29. Number of field trials and demonstrations of water saving and rain-fed agriculture technologies is the total number of water saving and rain-fed agriculture technologies that were introduced, experimented and demonstrated in a period of time by the public EAS agency.

IND./GR.30. Number of field trials and demonstrations of integrated pest management technologies is the total number of integrated pest management technologies that were introduced, experimented and demonstrated in a period of time by the public EAS agency.

IND./GR.31. Number of field trials and demonstrations of agroecological management technologies is the total number of agroecological management technologies that were introduced, experimented and demonstrated in a period of time by the public EAS agency.

IND./GR.32. Number of experiments and demonstrations of polyculture ponds refers to the times of experiments and demonstrations of polyculture ponds (such as fish-rice, fish-crab, etc. systems) conducted by the public EAS agents within a certain period of time.

IND./GR.33. Number of experiments and demonstrations of fish disease control technologies refers to the times of experiments and demonstrations of technologies related to fish disease control conducted by the public EAS agents within a certain period of time.

IND./GR.34. Number of experiments and demonstrations of agri-food products processing technologies refers to the times of experiments and demonstrations of agrifood products processing technologies related to cereal, fruit, vegetable, animal and fishery products conducted by the public EAS agents within a certain period of time.

IND./GR.35. Number of experiments and demonstrations of aquaponics technologies refers to the times of experiments and demonstrations of aquaponics technologies conducted by the public EAS agents within a certain period of time.

IND./GR.36. Number of experiments and demonstrations of agro-machinery for land preparing, harvesting and processing, etc. refers to the times of experiments and demonstrations of agro-machinery for land preparing, harvesting and processing, etc. conducted by the public EAS agents within a certain period of time.

IND./GR.37. Number of experiments and demonstrations of agricultural drones and robotics technologies refers to the times of experiments and demonstrations of agricultural drones and

robotics technologies conducted by the public EAS agents within a certain period of time.

IND./GR.38. Percentage of farmers who have received crop pest monitoring service: Crop pest monitoring means checking the fields, landscapes or other sites to identify which pests are present, how many there are, or what damage they have caused or are causing. Correctly identifying the pest is key to knowing whether a pest is likely to become a problem and determining the best management strategy. The percentage of farmers who have received crop pest monitoring service is derived by dividing the number of farmers that have received crop pest monitoring service during a specific period of time by the total number of farmers and multiplying by 100. This information can be collected by conducting a sample survey/ interview of farmers who have received crop pest monitoring service during a certain period of time. The percentage is extrapolated by using this formula: Number of farmers surveyed/interviewed who have received crop pest monitoring service during a specific period of time x 100 / total number of farmers.

IND./GR.39. Percentage of herders who have received pasture and grassland pest monitoring service is derived by dividing the number of herders who have received pasture and grassland pest monitoring service during a specific period of time by the total number of herders and multiplying by 100. This information can be collected by conducting a sample survey/interview of herders. The percentage is extrapolated by using this formula: Number of herders who have received pasture and grassland pest monitoring service during a specific period of time x 100 / total number of herders.

IND./GR.40. Percentage of livestock farmers who have received animal disease monitoring service is derived by dividing the number of livestock farmers who have received animal disease monitoring service during a specific period of time by the total number of livestock farmers and multiplying by 100. This information can be collected by conducting a sample survey/interview of livestock farmers. The percentage is extrapolated by using this formula: Number of livestock farmers who have received animal disease monitoring service during a specific period of time x 100 / total number of livestock farmers.

IND./GR.41. Percentage of farmers who have received fish disease monitoring service is derived by dividing the number of fish farmers who have received fish disease monitoring service during a specific period of time by the total number of fish farmers and multiplying by 100. This information can be collected by conducting a sample survey/interview of fish farmers. The percentage is extrapolated

by using this formula: Number of fish farmers who have received animal disease monitoring service during a specific period of time x 100 / total number of fish farmers.

IND./GR.42. Percentage of farmers who have received crop growth monitoring service is derived by dividing the number of farmers who have received crop growth monitoring service during a specific period of time by the total number of farmers and multiplying by 100. This information can be collected by conducting a sample survey/interview of farmers. The percentage is extrapolated by using this formula: Number of farmers who have received crop growth monitoring service during a specific period of time x 100 / total number of farmers.

IND./GR.43. Percentage of farmers who have received soil moisture monitoring service is derived by dividing the number of farmers who have received soil moisture monitoring service during a specific period of time by the total number of farmers and multiplying by 100. This information can be collected by conducting a sample survey/interview of farmers. The percentage is extrapolated by using this formula: Number of farmers who have received soil moisture monitoring service during a specific period of time x 100 / total number of farmers.

IND./GR.44. Percentage of herders who have received pasture and grassland monitoring service is derived by dividing the number of herders who have received pasture and grassland monitoring service during a specific period of time by the total number of herders and multiplying by 100. This information can be collected by conducting a sample survey/interview of herders. The percentage is extrapolated by using this formula: Number of herders who have received pasture and grassland monitoring service during a specific period of time x 100 / total number of herders.

IND./GR.45. Animal breeding environment monitoring is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./GR.46. Fish breeding environment monitoring is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./GR.47. Natural fishery resources monitoring is a qualitative indicator that requires a yes-no answer from the public EAS agents interviewed. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./GR.48. Percentage of farmers who have received drought warning service is derived by dividing the number of farmers who have received drought warning service during a specific period of time by the total number of farmers and multiplying by 100. This information can be collected by conducting a sample survey/ interview of farmers. The percentage is extrapolated by using this formula: Number of farmers who have received drought warning service during a specific period of time x 100 / total number of farmers.

IND./GR.49. Percentage of farmers who have received flood monitoring warning service is derived by dividing the number of farmers who have received flood monitoring warning service during a specific period of time by the total number of farmers and multiplying by 100. This information can be collected by conducting a sample survey/interview of farmers. The percentage is extrapolated by using this formula: Number of farmers who have received flood monitoring warning service during a specific period of time x 100 / total number of farmers.

IND./GR.50. Plant quarantine is referred to as the legal enforcement of the measures aimed to prevent pests from spreading or to prevent them from multiplying further in case they have already gained entry and have established in new restricted areas (Ecofriendly Pest Management for Food Security, 2016). This qualitative indicator aims to check whether this service is available. The information can be collected by asking a yes-no question during the sample survey of public EAS agencies. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./GR.51. Animal quarantine means the keeping in isolation of animals which are to be introduced in a herd or territory for a definite period of time as a preventive measure against the spread of infectious diseases in a healthy population. This qualitative indicator aims to check whether this service is available. The information can be collected by asking a yes-no question during the sample survey of public EAS agencies. It is up to the public EAS agents interviewed to describe the specific work undertaken according to the local context.

IND./GR.52. Number of inputs quality testing refers to the times of quality testing of principal agricultural inputs, such as seeds, pesticides, and chemical fertilizers, that were performed by the public EAS agency in a certain period of time.

IND./GR.53. Number of agricultural products quality and safety testing refers to the times of quality and safety testing of agricultural products, such as pesticide residue testing, that were performed by the public EAS agency in a certain period of time.

IND./GR.54. Number of quality certification of animal products refers to the times of quality certification of animal products (meat, poultry, dairy) that were performed by the public EAS agency in a certain period of time.

IND./GR.55. Number of crop and plant varieties verified, registered, introduced and extended refers to the total newly bred or introduced crop and plant varieties that were certified, released and extended by the public EAS agency in a certain period of time, to achieve large-scale production after the verification and evaluation of their extension value and adaptation range based on their regional test results and small-area production performance.

IND./GR.56. Number of livestock and poultry varieties verified, registered, introduced and extended refers to the total newly bred or introduced livestock and poultry varieties that were certified, released and extended by the public EAS agency in a certain period of time, to achieve large-scale production after the verification and evaluation of their extension value and adaptation range based on their regional test results and small-area production performance.

IND./GR.57. Number of fish varieties verified, registered, introduced and extended refers to the total newly bred or introduced fish varieties that were certified, released and extended by the public EAS agency in a certain period of time, to achieve large-scale production after the verification and evaluation of their extension value and adaptation range based on their regional test results and small-area production performance.

IND./GR.58. Percentage of farmers attending agronomic training is derived by dividing the number of farmers who have attended training or vocational education that is provided by the public EAS agency and aimed at improving their agronomic technical skills or soft skills during a specific period of time by the total number of farmers and multiplying by 100. This information can be collected by conducting a sample survey/interview of farmers. The percentage is extrapolated by using this formula: Number of farmers who have attended agronomic training or vocational education during a specific period of time x 100 / total number of farmers .

IND./GR.59. Percentage of farmers attending livestock training is derived by dividing the number of livestock farmers who have attended training or vocational education that is provided by the public EAS agency and aimed at improving their livestock technical skills or soft skills during a specific period of time by the total number of livestock farmers and multiplying by 100. This information can be collected by conducting a sample survey/interview of livestock farmers. The percentage is extrapolated by using this formula:

Number of farmers who have attended agronomic training or vocational education during a specific period of time x 100 / total number of livestock farmers.

IND./GR.60. Percentage of farmers attending fish farming training is derived by dividing the number of fish farmers who have attended training or vocational education that is provided by the public EAS agency and aimed at improving their fish farming technical skills or soft skills during a specific period of time by the total number of fish farming farmers and multiplying by 100. This information can be collected by conducting a sample survey/interview of fish farmers. The percentage is extrapolated by using this formula: Number of farmers who have attended fish farming training or vocational education during a specific period of time x 100 / total number of fish farmers.

IND./GR.61. Percentage of farmers attending agromachinery operation training is derived by dividing the number of farmers who have attended training that is provided by the public EAS agency and aimed at improving their skills to operate agricultural machinery during a specific period of time by the total number of farmers and multiplying by 100. This information can be collected by conducting a sample survey/interview of farmers. The percentage is extrapolated by using this formula: Number of farmers who have attended agromachinery operation training during a specific period of time x 100 / total number of farmers.

IND./GR.62. Percentage of farmers attending digital literacy training is derived by dividing the number of farmers who have attended training that is provided by the public EAS agency and aimed at improving their digital skills to use digital tools to access digital EAS during a specific period of time by the total number of farmers and multiplying by 100. This information can be collected by conducting a sample survey/interview of farmers. The percentage is extrapolated by using this formula: Number of farmers who have attended digital literacy training during a specific period of time x 100 / total number of farmers.

IND./GR.63. Number of agencies refers to the total number of public EAS agencies present and in operation in a subregional administrative division (e.g. county, township, village).

IND./GR.64. Number of public EAS agents refers to the total number of public EAS agents present and in operation in a subregional administrative division (e.g. county, township, village). These agents are recruited by and hence formal staff of public agencies and their salary is paid by the public budget.

IND./GR.65. Farmer-to-agent ratio is a commonly used measure designed to illustrate the number of clients each EAS agent is

expected to serve. The ratio is calculated by determining the total potential clients within a geographic area (district, region, nation) and dividing this figure by the total number of agents responsible for this area, scaled to a denominator of one. While high ratios suggest under-staffing and perhaps a high degree of unserved potential clients, recommendations for an ideal ratio are mixed and depend largely on the context and services provided (Swanson, Bentz and Sofranko, 1997).

IND./GR.66. Public expenditures on public EAS refer to the annual government spending on the provision and/or delivery of public EAS at the grassroots level incurred by subregional governments.

IND./GR.67. Public expenditures on public EAS as a percentage of total agricultural GDP refers to the total subregional government spending on public EAS which is expressed as a percentage of the GDP from the agricultural sector at the subregional level. This information is derived by dividing total government spending for public EAS by the agricultural GDP and multiply by 100. A higher percentage of agricultural GDP spent on public EAS shows a higher government priority for public EAS. When interpreting this indicator, one should be aware that due to EAS privatization, a higher proportion of the total funding for public EAS may be funded by the private sector in some countries, thus making public expenditure appear lower than in other countries.

IND./GR.68. Number and size (m^2) of office spaces measure the total number and acreage of offices that a public EAS agency possesses.

IND./GR.69. Number of travel vehicles refers to the number of vehicles such as motorbikes, bicycles, cars and so on that belong to the public EAS agency and EAS agents can use to deliver services.

IND./GR.70. Size (m^2) of fields for experiments and demonstration of new technologies and varieties refers to the acreage of fields that a public EAS agency possesses to conduct experiments and demonstration of new technologies and varieties.

IND./GR.71. Number and size (m^2) of well equipped labs refer to the number and acreage of well equipped labs that a public EAS agency possesses to test seeds, pesticide residue, fertilizer or soil.

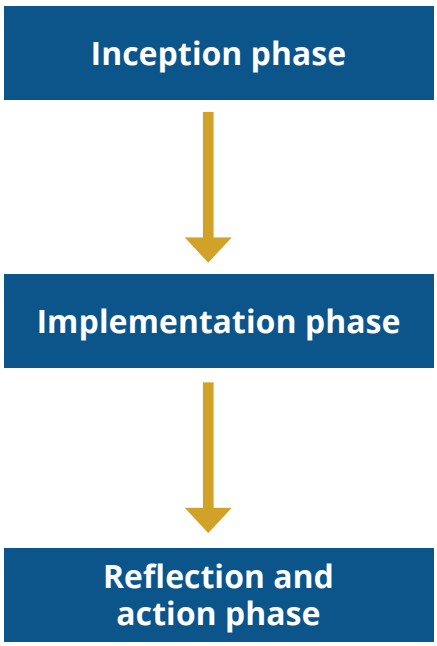
IND./GR.72. Size (m^2) of farmer training venues refers to the acreage of farmer training venues that a public EAS agency possesses to conduct farmer training activities.

IND./GR.73. Number of training facilities refers to the number of farmer training facilities, such as computers, projectors, whiteboards, tables, chairs and so on that a public EAS agency possesses to conduct farmer training activities.

6.4. Operational framework

An overview of the operational framework of the M&E of the public EAS system at the grassroots level is presented in Figure 3. It consists of three interlinked phases, namely, initiation, implementation, and reflection and action. A number of activities are to be undertaken in each phase. The operational framework should be tailored and adapted to the specific local M&E situation. This is meant to meet the objectives as well as to take into consideration the capacities, resources available, and time needed to effectively conduct the M&E. The M&E process of the public EAS system features a reflective learning cycle, as it organizes reflection and refinement workshops as well as capacity building events.

FIGURE 3. **Operational framework of the public extension and advisory service system's monitoring and evaluation at the grassroots level**



Source: Authors' own elaboration.

6.4.1 Initiation phase

The main objectives of the initiation phase are to (1) create local EAS ownership, (2) empower EAS agents or organizations at grassroots EAS agencies to define the M&E scope, and (3) develop capacity at the sub-regional (e.g. prefecture, county or lower levels) levels to carry out the self-M&E. The self-M&E can be conducted as a normative management activity of the grassroots public EAS system, a project or a case study. In all cases,

it is critical that public EAS agents are committed and actively involved in the entire process from the initiation to the implementation, reflection and action phases.

M&E perceived by this guide are at best an internal activity. Building trust and developing a common goal for the M&E are essential for creating ownership of local public EAS agencies and agents. This will also facilitate endorsement of the M&E findings and application of the results in concrete actions. The following activities are suggested for the initiation phase:

- establishing a team composed of management specialists within the public EAS system or assigned by the public EAS management to be in charge of the M&E;
- developing the mandates or the ToRs for the M&E team, defining the rationale of the M&E with specific objectives, clarifying expectations, agreeing on a common vision, and identifying entry points for the M&E;
- mapping actors, characterizing the boundary of the public EAS system, and taking stock analysis of key challenges, opportunities, and constraints of the public EAS system;
- carrying out an inception workshop to define the scope and key questions from the perspective of public EAS stakeholders; and
- conducting necessary training activities or courses to build the capacities of the M&E team. The role of EAS can vary depending on the country or location context, priorities of the agrifood sector, and different mechanisms in place as well as farmers' demands.

6.4.2 Implementation phase

It is crucial to understand the local context at the beginning of the M&E. Taking into consideration farmers' needs before monitoring and evaluating the public EAS system helps identify bottlenecks, gaps and constraints of the public EAS delivered. For example, interviews with public EAS clients will address and include aspects of systems analysis (such as functions, services and key EAS stakeholders). M&E of the public EAS system should collect data and information from different sources during the implementation phase. Data often include secondary information from desk reviews and the primary information from interviews, stakeholder workshops, field observations and so on. Considering that some data tend to be difficult (missing at the grassroots level) to get based on the desk study, a series of semi-structured interviews are to be conducted with key public EAS stakeholders. The list of stakeholders to be interviewed is determined by the findings from the literature review. Telephone or

video interviews can be held with the selected stakeholders. The following activities are suggested for the implementation phase:

- reviewing secondary data sources to get necessary background information on making decisions on selecting key informants, farmer interviews, and direct field observation schemes;
- interviewing sample farmers to assess their experience with and reflections on the following aspects of public EAS systems in terms of the efficiency, effectiveness and relevance of the public EAS provided. Interviews will mainly seek information on the accessibility, affordability, adaptability, accountability, and coordination of public EAS;
- interviewing policy and regulatory representatives, including legislators or policymakers at subregional levels and relevant officers from government extension and regulatory departments. They are generally in charge of regulating EAS quality and provision. Interviews may focus on how they view public EAS systems, the functions of licensed or authorized law enforcement of technical agricultural EAS (such as quality and market supervisions for agricultural inputs including seeds, fertilizers and pesticides, etc.), and existing gaps;
- interviewing non-public EAS providers, including researchers, farmer organizations, NGOs (community facilitators, knowledge facilitators), private agribusinesses (market intermediaries), etc. to gain an insight into their experience with and reflections on the public EAS systems;
- observing field trials, experiments, demonstration and farmer training and advisory activities and/or participating in the field activities of public EAS;
- analyzing and interpreting the collected data and formulating a preliminary M&E report based on M&E results; and
- organizing mini-workshops for reflection and learning for consolidating the preliminary M&E report.

6.4.3 Reflection and action phase

The results of M&E of the public EAS system should be thoroughly and widely discussed with EAS managers, policy decision-makers and wider groups of EAS stakeholders. On this basis, action plans are to be developed, validated and implemented. This phase consists of a series of proposed activities as follows:

- organizing a participatory and multistakeholder reflection and validation workshop;
- preparing a final M&E report with the gaps identified and comments and suggestions for actions collected from the reflection and validation workshop;
- organizing EAS management and policy dialogue events; and
- developing, validating and implementing action plans on reforming and strengthening public EAS systems to fill the identified gaps.

7. Data sources and collection

7.1 Data sources

The availability of accurate, robust and updated data and information is critical to make the M&E of the public EAS system effective and meaningful. Data can be collected from primary and secondary sources. Primary sources include interviews, questionnaire surveys, focus group discussions, field observations and so on. Data collected from these sources are primary data as they are the first-hand data gathered by the M&E specialists themselves. Secondary sources include (1) public documents such as annual work reports, agricultural development plans, policies and laws, farmers' survey reports and so on created by the ministry of agriculture and other related ministries, departments, agencies or directorates in charge of EAS, research institutes related to agricultural and rural development, etc.; (2) documents such as project completion reports, project assessment reports, case studies, etc. prepared by international and national NGOs and international research institutes; (3) academic papers; (4) and statistics and census data from national bureau of statistics and thematic data from international organizations related to development, such as World Bank, FAO, Organisation for Economic Co-operation and Development (OECD), International Telecommunication Union (ITU), just to name a few. Data gathered from these sources are secondary data as they were created by others and used in the past. It is worth noting that not all of these documents and statistical/census data are published and made accessible to the public.

7.2 Data collection approaches

According to the data sources, data collection, both primary and secondary data collection, can be divided into two categories: quantitative methods and qualitative methods. Commonly used data collection methods are as

follows. While the first four are commonly used for collecting primary data, the last two are useful for collecting secondary data.

Key informant interviews: During such interviews, M&E specialists often ask semi-structured questions either vis-à-vis or via Internet or telephone to the key informants of the EAS system, such as competent authorities, EAS agents, clients and so on. When vis-à-vis interviews are not feasible or appropriate, M&E specialists can conduct interviews online or via telephone. Certain categories of interviewees (EAS stakeholders such as farmers who have accessed public EAS) can be selected using a purposeful random sampling technique (Emeana *et al.*, 2019). As a time-consuming data collection approach, key informant interviews are suitable when there are only a few key informants.

Focus groups discussions (FGD): A focus group is often composed of a small group of representatives of EAS stakeholders and a moderator. Altogether, they discuss some key issues related to EAS from their own perspective.

Questionnaire surveys: Respondents (EAS-related stakeholders) are required to answer, based on their knowledge and experience with the public EAS, a set of questions that are either open-ended or closed-ended.

Field observation: Data can be collected through field observations, where M&E specialists either observe the immediate results of EAS activities or the EAS clients to gauge a particular behaviour or attitude.

Existing data collection: Mostly, quantitative data can be collected from existing verifiable data sources that are easily accessible. Such sources include national bureau of statistics (for gathering statistics and census data) and data banks (for gathering thematic data) created by international organizations such as the World Bank, FAO, OECD, ITU and so on.

Literature review: Literature review is a process wherein existing academic and non-academic documents are reviewed to collect data. It is an efficient and effective way of collecting data from the past. Documents that can be collected and reviewed include (1) documents created by the public institutions in charge of agricultural and rural development such as annual work reports, agricultural development plans, policies and laws, farmers' survey reports and so on; (2) documents created by international and national NGOs and international research institutes such as project completion reports, project assessment reports, case studies and so on; and (3) academic papers on the topics of agriculture and EAS systems.

Different data collection methods are to be used depending on the specific M&E contents and purposes. The selection of data collection methods is also determined by the size of the sample and its geographical dispersion, as well as on the time and resources available

(Sulaiman V *et al*., 2022b). Usually, the data collection methods listed above are to be applied in combination. For example, for data on inputs like infrastructure and enabling environment such as policy or regulatory framework, the following data collection methods can be deployed:

- interview with government institutions in charge of agricultural and rural development, agricultural research institutes, etc.;
- statistical and census data collection from national bureau of statistics and thematic data from international organizations related to development;
- review of research reports, websites, studies conducted by international and national NGOs or institutes; and
- field observations.

Data on the required (demand side) and available (supply) mandates of the public EAS system are of great importance for identifying the gaps of the current public EAS system. The following data collection methods, which combine both the information from service providers and service users (particularly smallholder farmers), can be deployed in combination:

- workshop with stakeholders to generate an initial idea of the required and available/lacking mandates and services;
- interviews or FGD with EAS stakeholders, including EAS agents, clients, researchers, etc., to deepen the understanding of what is needed and available/lacking on the ground;
- literature review to identify lacking or missing mandates by better understanding frame conditions and the goals of national or regional agricultural development;
- review of reports on EAS activities and farmers' survey reports (if any) prepared by EAS agencies;
- field observations; and
- interviews with government institutions which have provided training to EAS agents and review of the curricula.

For data on funding, data can be collected through the following approaches:

- interviews with the key informants, especially authorities from government institutions in charge of agricultural and rural development (like ministry of agriculture), directorates or

departments responsible for EAS provision and management, etc.; and

- review of the financial documents of government institutions and agencies responsible for agricultural and rural development and EAS provision.

As the frame conditions and priorities of M&E activities tend to change, data collection methods are to be reviewed and adjusted on a regular basis. This is critical to build up a reliable and robust data bank over time.

BOX 4: Commonly used data collection methods

In terms of data collection methods, the general trend is towards participatory and mixed methods. For example, Ogueri (2013) used participatory methods including interviews, focus group discussions (FGDs) and questionnaires to evaluate agricultural EAS messages that support adoption of improved cassava production technologies in Nigeria. USAID (2018) used a mixed-methods approach of a literature review and 53 in-person and remote interviews conducted with key EAS stakeholders and actors in Mali. The literature review included reports from Malian governmental agencies, foreign governments, donor agencies, donor-financed projects, non-governmental organizations (NGOs), international organizations and universities. This information was supplemented with the in-person and telephone interviews with selected key informants in Mali in September 2017. Kamruzzaman and others (2021) used surveys and interviews from farmers affiliated with DAE (Department of Agricultural Extension) (150 DAE-farmers) and farmers independent of DAE (150 non-DAE farmers) to assess the role of EAS in strengthening farmers' innovation networks to adapt to climate extremes in Bangladesh. Key informant interviews were later conducted with five DAE farmers and five non-DAE farmers. In addition, an FGD with 12 DAE-farmers was conducted.

Source: **Kamruzzaman, M., Daniell, K.A., Chowdhury, A. & Crimp, S.** 2021. The role of extension and advisory services in strengthening farmers' innovation networks to adapt to climate extremes. *Sustainability*, 13, 1941. https://doi.org/10.3390/su13041941

Ogueri, E.I. 2013. Evaluation of agricultural extension messages that support adoption of improved cassava production technologies: A case of public and private sector extension in Rivers State, Nigeria. *OIDA International Journal of Sustainable Development*, 6(4): 11–24.

USAID. 2018. *Mali: In-depth assessment of extension and advisory services.* Developing Local Extension Capacity Project. Washington, D.C., USAID.

BOX 5: Importance of clients' perspective in monitoring and evaluation

The effectiveness of EAS depends on the way they address clients' demands as well as the kind of relationships that EAS providers have with their clients. Assessment of clients' perspectives thus sets out to understand the main needs and demands of EAS clients, as well as their perceptions on EAS delivery. A sound understanding of clients' perspective on the effect of EAS on their production, market access, and income; and on their technical and functional capacities (e.g. behavioural and mindset change) is critical to assess the relevance, effectiveness, and downward accountability of the public EAS system.

When assessing clients' needs, M&E specialists should bear in mind that the diversity of rural producers and existing inequalities among them often translate into unequal power dynamics within a community and thus within any group invited to a workshop, interview or focus group discussion (FGD). More vulnerable groups and individuals may either not attend the interview, their voices might be drowned out by more outspoken interviewees or stifled by their fear of describing their problems in front of others. Efforts should thus be made, where possible, to work around these issues, for example by facilitating separate FGDs or interviews with more marginalized groups or individuals to ensure that their perspectives are captured.

Source: **Sulaiman V, R., Chuluunbaatar, D., Mroczek, Z.K., Alexandrova, N., Holley, A. & Mittal, N.** 2022b. *Comprehensive assessment of national extension and advisory service systems – An operational guide*. Rome, FAO. https://doi.org/10.4060/cb9111en

8. Capacity building for monitoring and evaluation

Lack of capacity to undertake self-M&E is one of the major constraints faced by EAS systems in many countries (Sulaiman V *et al*., 2022b). Due to a lack of human resources and the associated capacities, M&E tend to be inefficient and ineffective (Lai, 2012). Lack of skilled M&E personnel especially at the subregional level is exacerbated by a lack of M&E training either at pre-service or post-entry (ibid.). To enhance the capacity, it is crucial to, on the one hand, build up a team of EAS agents within the public EAS system who are capable of undertaking M&E activities; and on the other hand, to provide relevant training on the M&E methodology. This will enhance the M&E process and results (Sulaiman V *et al*., 2022b).

8.1 Institutionalizing monitoring and evaluation

Currently, public EAS systems in most developing countries have quite weak self-M&E system, especially at the subregional levels. They often have no M&E team and scarce capacities to undertake self-M&E on a regular basis. It is therefore necessary to institutionalize the M&E system as an integral component of the public EAS system. The institutionalization first and foremost demands a coherent political will to improve the performance of public EAS. This requires that competent authorities give sufficient priority to the self-M&E of the public EAS system, considering it as an important tool to generate evidences to guide the reform and strengthening of the public EAS system. Second, institutional rearrangements are needed to build up a functioning M&E structure. Ideally, an M&E division or unit is to be established within the public EAS system at the national, regional, and subregional levels. Third, efforts should be made to build a strong M&E specialists team composed of well trained and motivated public EAS agents. Therefore, their capacities and motivation to undertake M&E activities are to be strengthened in the long run. Finally, continued investments are to be secured so as to maintain the operation of the self-M&E system, build

capacities of EAS agents, and provide necessary incentives and improve their work conditions. This is important for creating a motivating and enabling environment wherein all public EAS agents are willing to and capable of taking part in M&E activities.

8.2 Training on monitoring and evaluation

Countries need to develop their capacities to not only evaluate historical and current experiences in implementing different EAS reforms (Blum *et al*., 2020), but also monitor and evaluate by themselves the performance of existing EAS on a continued basis. This is because that enhanced self-M&E capacities are critical to better support the reform and strengthening of the public EAS system. M&E capacity building should be considered as an integral component of the self-M&E system within the public EAS system. It is to be integrated with the broader capacity building strategies of the public EAS system (Lai, 2012).

M&E training should comprise three major areas. First, public EAS agents are to be trained on the M&E frameworks as are proposed in this guide. For public EAS agents at the national level, they should get familiarized with the M&E module at the national level. As for public EAS agents at the subregional (e.g. prefecture, township, village) levels, they should become informed of the M&E module at the grassroots level. Second, public EAS agents need training on how to collect and analyse data. M&E are intrinsically linked to accountability and to the quality assurance of services. If accountability is to be strengthened, data collection and analysis methodology needs to be made part of a wider training strategy for public EAS agents, which will enable them to not only gather and analyse data but also to define indicators according to local contexts and specific needs (FAO and KIT, 2016). Third, public EAS agents and managers, especially decision-makers, are to be trained on how to use the M&E results. A major factor that limits M&E's potential to help improve the performance of public EAS is that M&E results are often poorly or even hardly used to guide the reform and strengthening of the public EAS system. Therefore, it is vital for public EAS agents and managers to refer to the M&E results to identify the gaps and loopholes in the existing public EAS system. On this basis, necessary interventions are to be defined and undertaken during the EAS delivery.

BOX 6: Monitoring and evaluation capacity building

In Belize, the Monitoring and Evaluation Unit has focused on providing support to projectize and monitor work plans. To facilitate this process, programme directors and coordinators actively participated in a Project Cycle Management training, conducted in May 2015 by Ten Step Method trainer Menno Valkenburg from The Netherlands. The training exposed participants to the theory and practices in project cycle management. Equipped with this knowledge and the support of the M&E Unit, coordinators and programme directors have been developing projects for sponsorship. Basic project and monitoring formats have also been developed and shared with officers in order to facilitate the M&E process within the Ministry.

In the Philippines, the Planning, Monitoring and Evaluation Unit under the Agricultural Training Institute (ATI) of the Department of Agriculture (DA) formulates guidelines in the M&E of ATI's AFE programmes. For Extension System Planning, Monitoring and Evaluation, the unit institutionalizes system planning at the national and regional level, as well as conducting semestral meetings to strengthen the Agriculture and Fisheries Extension Network (AFEN). It develops and disseminates modules to build the institute's capacity on strategic planning, as well as modules on Results Based Monitoring and Evaluation (RBME) to capacitate stakeholders in the M&E of AFE programmes.

Source: **Ministry of Agriculture, Food Security, and Enterprises of Belize.** 2022. *Monitoring and Evaluation Unit.* Cited 16 March 2022. https://www.agriculture.gov.bz/monitoring-and-evaluation-unit/

Planning, Monitoring and Evaluation Unit under the Agricultural Training Institute of the Department of Agriculture of the Philippines. 2022. *Policy Planning.* Cited 19 March 2022. https://ati.da.gov.ph/ati-5/programmes/policy-planning

9. Integrated analytical frameworks of monitoring and evaluation

The public EAS system's self-M&E system is critical for maintaining the effectiveness, relevance and quality of public EAS. It often involves related activities at multiple administrative levels, including grassroots, regional and national levels. It also requires related activities at multiple dimensions, such as structural, functional, capacity and enabling environment aspects of the public EAS system. Given that M&E activities tend to be comprehensive and complicated, they must be analysed in an integrated approach. The following considerations should be taken into for analysing the M&E results of public EAS in an integrated way. They are necessary especially for comparing different EAS systems, analysing constraints, identifying existing gaps, and developing action plans.

9.1 Weighting of indicators

Indicators can be weighted in accordance with their degree of being essential for a snapshot of the public EAS system. This is necessary as it is often times not uncommon that public EAS systems face both financial and human resource constraints for undertaking data collection. Considering this common limitation, the weighting of indicators proves to be important as it can underpin the allocation of resources for collecting data (indicators) that have the greatest potential to bring about change within the public EAS system.

A weighting system can be used by scoring 1 (least essential) to 5 (most essential) to the proposed indicators to single out the most important indicators. In doing so, a set of indicators can be selected from the proposed indicator frameworks. Out of these, some could be identified as "core" indicators based on their relative importance for the overall performance of the public EAS system in comparison to the other indicators, while the rest of the indicators were considered as "complementary". In other words, these "core" indicators represent the most essential information, or minimum dataset required for a snapshot of the EAS system, while the

"complementary" indicators, less essential, provide a more detailed picture of the EAS system (Sulaiman V *et al*., 2022a).

Apart from considering their degree of being essential, three considerations are useful for the selection of indicators to be weighted so as to have a synoptic review of the public EAS system. First, the selection is to be guided by the objective to have a "systemic diagnosis" of the public EAS system in terms of structure, functions, capacities, and enabling environment as well as key outputs and outcomes. Second, the indicator selection can refer to the suggestions made in several publications on EAS evaluation (Birner *et al*., 2012; Blum *et al*., 2020; Chipeta, 2019; Davis *et al*., 2020; Faure, 2016 cit in Sulaiman V *et al*., 2022a). Third, the weighted indicators can be defined through evaluations made by EAS experts and/or stakeholders. A workshop or a panel can be organized where the weight for each indicator can be determined according to the average estimation of an EAS expert panel or the key stakeholders.

9.2 Scoring method

A scoring method can be developed to comprehensively use a set of qualitative and quantitative indicators to obtain a straightforward diagnosis of the current functionality and performance of the entire public EAS system. The set of indicators can cover the aspects of EAS system structure, function, capacity, enabling environment and key outputs and outcomes. They are to be selected from the proposed indicator frameworks. Non-listed indicators can also be identified and added in accordance with country-specific situations. Of the selected indicators, some can be identified as "core" based on their relative importance in comparison to the other indicators, while the rest of the selected indicators are considered as "complementary". Different weights are to be given to the core and complementary indicators using the weighting method mentioned in section 9.1. The scoring method of the set of selected indicators can be developed using the following mathematical formula:

$$AT_i = \sum_{i=1}^{n} W_i B_i$$

In this formula, AT_i is the score of the set of selected indicators. W_i is the weight of a certain indicator, B_i is the value of the indicator, and N is the number of indicators. The selected indicators include both positive and negative indicators. A positive indicator means that the target value is higher than the actual value, so the EAS work target is increasing. Taking agricultural output as an example: The national target is 1 000 kg/unit area, and the current actual output is 800 kg/unit area. Then this indicator is a positive one. A negative indicator means that the target value is lower than the actual value, so the EAS work target is decreasing. Taking the application of chemical fertilizer as an example: The national target is to apply 10

kg/unit area, but the current actual application is 20 kg/unit area. Then this indicator is a negative one. The target value depends on the national agricultural development goals and farmers' needs, while the actual value depends on the *status quo* data collected through survey and/or statistical data that reflect the current situation. The following steps are suggested to score the public EAS system:

Step one: Calculate the B_i for each selected indicator. The B_i can be calculated in accordance with either the actual value (AV) as a percentage of target value (TV) of a certain indicator (for positive indicators) or the target value as a percentage of actual value of a certain indicator (for negative indicators):

$$B_i = 100 \times \frac{i\,(AV)}{i\,(TV)} \quad \text{(Positive indicators, } 0 < B_i \leq 100\text{)}$$

$$B_i = 100 \times \frac{i\,(TV)}{i\,(AV)} \quad \text{(Negative indicators, } 0 < B_i \leq 100\text{)}$$

Step two: Determine the weight of each selected indicator. The weight for each indicator can be determined according to the average estimation of an EAS expert panel or the key stakeholders.

Step three: Calculate the score of the public EAS system based on the set of selected indicators using the data collected in the M&E process.

The proposed scoring method is useful in three ways. First, it can be used to score the entire public EAS system at the national, regional and grass-roots levels. Second, as the scoring method can be used to score individual indicators, it is useful for identifying gaps in the existing public EAS system. For example, for the M&E module at the national level, it can be applied to systematically diagnose the gaps in the public EAS system in terms of structure, functions, capacities and enabling environment as well as key outputs and outcomes. For the M&E module at the grassroots level, it can be used to identify the main gaps in terms of inputs, activities, outcomes and outputs of EAS. Third, the method is also useful for conducting comparative analyses of public EAS systems of different countries and regions.

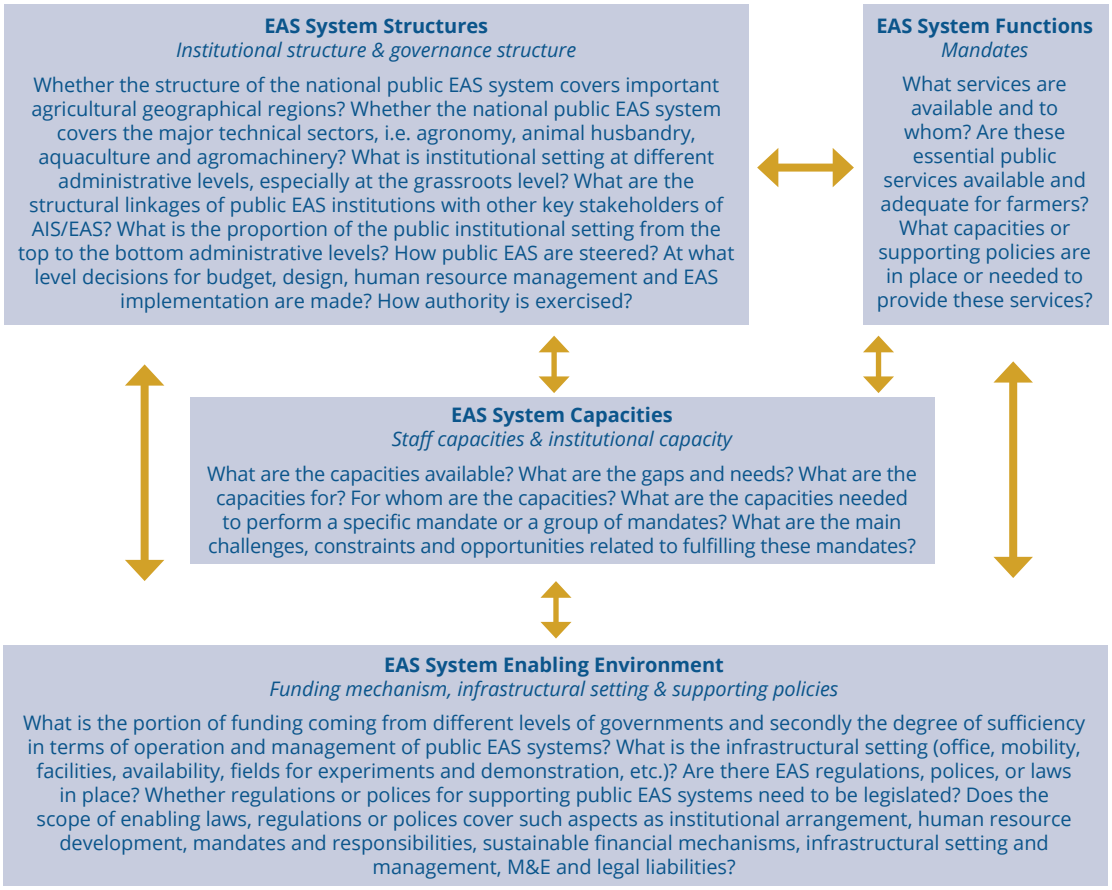
9.3 Multidimensional analytical framework

This guide proposes a multidimensional M&E analytical framework (Figure 4) to assess in a systemic and holistic way, namely, at the structural, functional, capacity, and enabling environment levels of the public EAS system. The proposed framework serves as a reference for countries to tailor country-specific analytical frameworks, namely, by adapting it to the characteristics of the public EAS system. On the one hand, this framework puts an emphasis on the identification of gaps and loopholes in the existing

public EAS system. On the other hand, it aims to help develop systematic instruments for strengthening the public EAS system based on system-wide analyses. The proposed analytical framework seeks to answer the following basic questions: How does the public EAS system's structure influence its functions? What are the individual and institutional capacities needed to fulfil specific functions of the public EAS system? (3) Do existing actors of the public EAS system have the capacities to fulfil the functions required by the national agricultural development goals and farmers? How the current environment is enabling or disabling the complex interrelationships between the structure, functions and capacities of the public EAS system?

The proposed multidimensional M&E analytical framework highlights that M&E analyses should go beyond the individual dimensions to take into consideration the interactions and relationships between the four dimensions, namely, structures, functions, capacities, and enabling environment (FAO, 2022). The focus should be on how these four dimensions interact to affect the overall performance of the public EAS system. A brief overview of the four dimensions is provided as follows:

FIGURE 4. **Multidimensional monitoring and evaluation analytical framework**



Source: Authors' own elaboration.

Analysis of structure: The public EAS system's actors in terms of their composition, diversity, roles, interactions, complementarity and networks are to be identified and mapped. A key output of the analysis is a map of the actors as well as their interactions and networks (e.g. power relations, influence and importance, decision-making, resources sharing, etc.) and their roles in the public EAS system. Some key questions to guide this analysis include but not limited to: Who are the actors? What are their roles and interactions? How do they network and collaborate in the public EAS delivery? What are the power relations? How actors, their interactions and networks contribute to the public EAS and influence their functions? The analysis of the structure of the public EAS system requires a shift towards an understanding of the entire EAS system and the relationship among different system components. The action plans developed based on the M&E results should enable actors to understand each other's perspectives and manage diversity and potential conflicts. This is critical to create scenarios wherein the benefits of their complementarity can be harnessed, thereby paving the way for building networks and partnerships to enhance collaborations.

Analysis of functions: To analyse the functions of the public EAS system, a checklist of its functions should be provided that can be monitored and evaluated. A key output of this analysis is to identify the functions performed, coverage of services and levels of satisfaction of clients (mainly farmers). This will allow identifying the gaps and loopholes in the existing public EAS system. Many factors affect positively or negatively the overall performance of the public EAS system. Main functions of the public EAS system are documented in the mandates such as provision of public agricultural EAS, training, specific kind of agricultural law enforcement authorized by the government and so on. Possible questions to guide the analysis include: What are the main functions performed? How and who perform these functions? What is the level of satisfaction? How does collaboration take place for a specific function? What are the constraints for each function identified?

Analysis of capacity: The analysis is focused on individual and institutional capacities[6] within the public EAS system, covering both the technical and functional aspects of capacities. Technical capacities are related to the mandates of the actors while functional capacities focus on their soft skills (such as organization, communication, cooperation and facilitation skills). Capacity analysis aims at identifying and analysing existing or available capacities and desired capacities for better achieving the objectives of the public EAS system. Possible questions

[6] Within the public EAS system, the capacity at the individual dimension requires the acquisition of knowledge and skills to develop the capacity to adapt and respond to emerging needs of EAS clients, while the capacity at institutional level requires that a public EAS agency effectively manages the core competencies of individuals and relates to external actors (FAO, 2022).

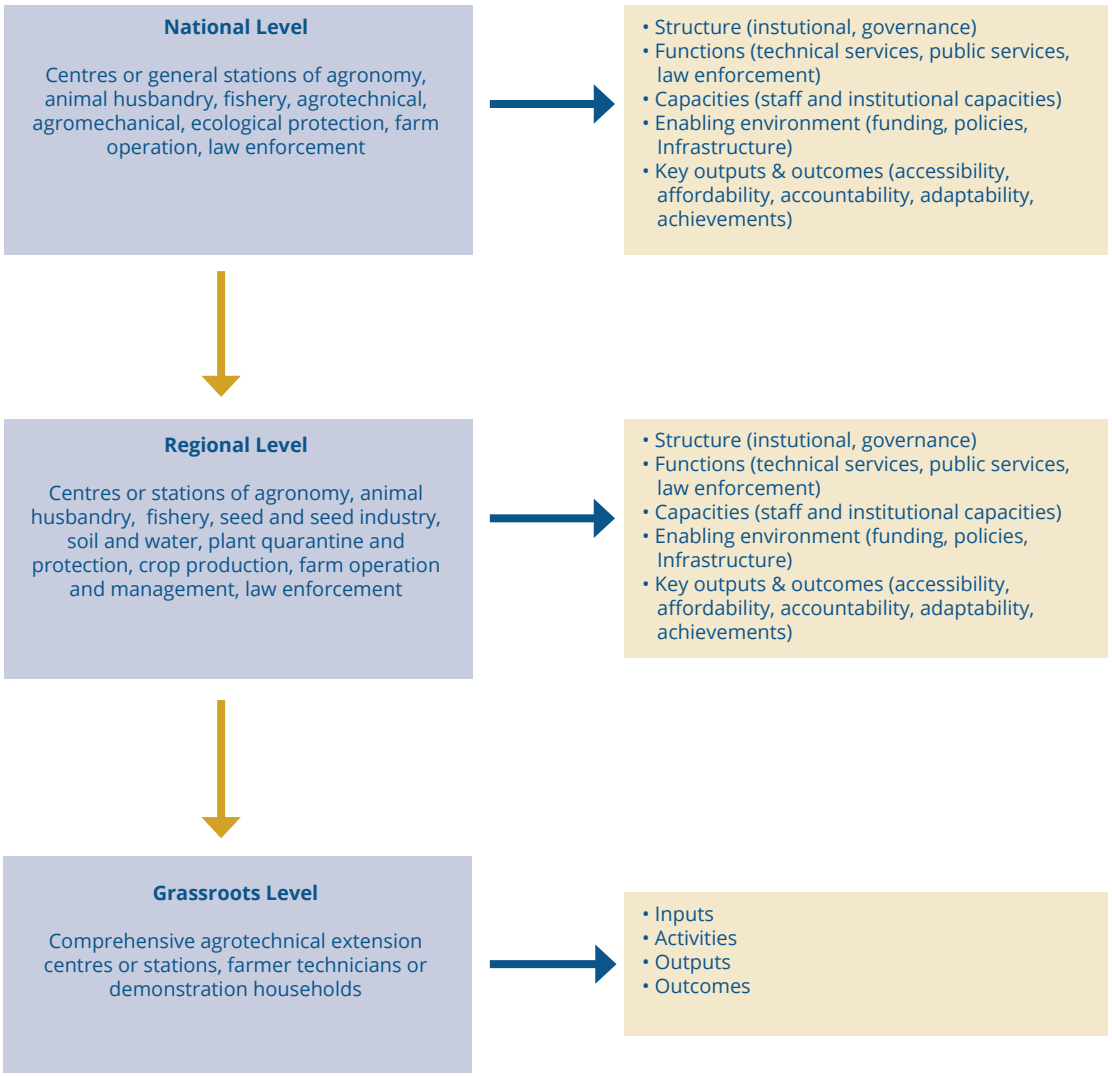
may include: What are the capacities available? What are the gaps and needs? Capacity for whom and for what? What are their capacities to perform a specific or group of functions? What are the main challenges, constraints and opportunities related to fulfilling the functions?

Analysis of enabling environment: The analysis is focused on the key components of an enabling environment for public EAS provision, namely, policies, strategies, governance of the public EAS system, infrastructure, and policy instruments (e.g. public-private partnerships, financial incentives). Key questions to guide the analysis include: What are the policies, strategies related to the public EAS system? How do they foster, promote, and facilitate public EAS? How are the structure, functions and capacities affected by public EAS policies? What and how effective are the existing policy instruments? Are there infrastructures to support the public EAS systems? What are the major challenges faced by the public EAS system?

9.4 Multilevel analytical framework

A country's public EAS system is normally composed of EAS agencies at the grassroots, regional and national levels (Figure 5). Accordingly, its self-M&E should be addressed in an institutional hierarchy, that is, at various administrative levels from the top to the bottom. At the grassroots level, public EAS agencies or stations provide services with a specific focus, such as the intensification of a specific crop, food safety, a specific value chain development, agricultural inputs services or quality management, soil test, crop pest monitoring and forecasting, knowledge and technology transfer and so on. Accordingly, the public EAS system's self-M&E at the local level should focus on assessing the inputs, activities, outputs and outcomes related to these services. On this basis, it will be possible to measure the relevance, efficiency, effectiveness and quality of services provided to clients (mainly farmers) and develop action plans to fill the identified gaps. In contrast, the self-M&E of the public EAS system at the regional or country level should focus on "diagnosing" the system with a holistic approach, examining the system structure, functions, capacities, and enabling environment. It should pay special attention to the institutional, functional and governance structures in which power relations and institutional dimensions determine whether different levels of public EAS actors contribute to attain the system's functionality and sustainability. A multilevel M&E analytical framework of the public EAS system is proposed below (Figure 5).

FIGURE 5. **Multilevel monitoring and evaluation analytical framework of the public extension and advisory service system**



Source: Authors' own elaboration.

National level analysis: The establishment of the public EAS system at the national level is largely determined by the national priorities of agricultural development and changing complexity in agrifood systems. The main functions of public EAS agencies at the national level should include managing the public EAS system, building capacities, creating an enabling environment, planning and implementing national public EAS programmes, and building partnerships and linkages with other key stakeholders. A more systemic and holistic approach is necessary to analyse the M&E results at the national level. More attention is to

be paid to strengthen system-wide capacities that involve factors that influence the management of EAS agencies and in particular the interactions among these agencies and other stakeholders. Possible questions to guide the analysis include: Are the institutional framework of the EAS system appropriate? How can the public agencies at the national level support the EAS system in terms of institutional reforms, orientation of services, capacity building, and enabling environment? Is the system sustainable? How can it ensure that essential public EAS are accessible, affordable, adaptable and accountable to clients, especially to smallholder farmers?

Regional level analysis: As public EAS are characteristic of territorial management, commitment to territorial development should be expressed through identifying regional priorities for agricultural EAS (Patricio Molina, 2010). The main functions of public EAS agencies at the regional level should cover system governance and management, capacity building, and enabling environment creation according to territorial and regional contexts and priorities. Neo-institutionalism fueled by territorial and regional networks has an important role to play in promoting exchange, mutual learning, and collaboration among multiple territorial and regional public EAS stakeholders. Analysing the M&E results of public EAS agencies at the regional level should focus on region-wide factors that influence the management of these agencies, and particularly their linkages with downward public EAS agencies at the grassroots level and upward agencies at the national level, as well as with other regional stakeholders such as education and research institutes as well. Possible questions to guide the analysis include: Are the regional priorities of the agrifood systems addressed by regional public EAS agencies? What are the relationships in terms of governance and management among the public EAS agencies at the regional, national and grassroots levels? What are the objectives of the public EAS system at the regional and subregional levels?

Grassroots level analysis: The main objectives of the public EAS agencies at the grassroots level are providing public EAS to farmers directly. The effectiveness of the public EAS system can be substantially enhanced if it engages in systematic self-M&E of its performance. Analysing the M&E results of public EAS agencies at the grassroots level should put priorities on the analysis of the relevance, effectiveness, and efficiency of their services. Possible questions to guide the analysis should be answered by the clients (mainly farmers). The analysis of the M&E results should provide a good understanding of how the current performance of the public EAS system at the grassroots level is, and how it contributes to skills development, behavioural change, and livelihoods improvement for its clients.

The multilevel M&E analytical framework is proposed to answer the

following questions: (1) Is the structure of public EAS systems at different levels appropriate for their functions? (2) What are the individual and institutional capacities at different levels to fulfil specific functions of public EAS systems at the national, regional and grassroots levels? (3) How to enhance the relevance, effectiveness, and efficiency of public EAS through institutional reforms at different levels? (4) How to strengthen the capacities of public EAS agencies at different levels to cope with existing and emerging challenges?

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Glossary

Accessibility of extension and advisory services refers to the quality of being able to be easily reached and used by EAS clients. It is a major indicator of the functionality of public EAS systems and their relevance and responsiveness to the various needs of service users. It can be considered as a performance criterion for governments, reflecting their capacities to accurately recognize the diversity and nature of different needs, create and tailor delivery and communication channels accordingly, and ensure equity and fairness in delivery and distribution (OECD, 2013).

Accountability of extension and advisory services refers to the responsibility and the relationships that a service provider has towards its users (downward accountability) and its donors or bureaucratic hierarchies (upward accountability) (Blum *et al*., 2020).

Actors are individuals and organizations (for example civil society, private sector, enterprises, government ministries, non-governmental organizations, research and development institutes, extension services, universities and vocational training centres, etc.).

Adaptability of extension and advisory services is an indicator to measure the ability of the existing EAS system to continuously change itself so as to adapt its institutional arrangements to changing context and environment. Adaptability is important considering that the socio-economic and policy environment in which EAS are formulated and operated is ever changing. This tends to bring about shocks to EAS systems which will affect their relevance, efficiency, and responsiveness. Consequently, the scope and goals of EAS systems are constantly changing.

Affordability of extension and advisory services is essentially about inclusiveness and equity, especially for smallholder farmers and other vulnerable farmer groups. Many tasks of public EAS have a public-

good nature, including tasks related to regulation, quality control in the produce supply chain, the coordination of service provision, and natural resource management, as well as the provision of services to marginal or poor groups that are not likely to access or afford private EAS (Blum *et al*., 2020). The main challenge to guarantee this public-good nature that public agricultural EAS systems face is how to develop low-cost, sustainable approaches to providing information and services (Tsafack *et al*., 2015).

Agricultural extension and advisory services (EAS) consist of all the different activities that provide the information and services needed and requested by farmers and other actors in rural settings to assist them in developing their own technical, organizational and management skills and practices to improve their livelihoods, as well as promote more sustainable agriculture. They include the diversity of actors involved in the EAS provision, and the broad support provided to rural communities (beyond information and knowledge), embracing new functions such as facilitation, intermediation, advice and brokering (Sulaiman & Davis, 2012; Christoplos, 2010).

Agricultural innovation is the process whereby individuals or organizations bring new or existing products, processes or ways of organization into use for the first time in a specific context, to increase effectiveness, competitiveness and resilience, with the goal of solving a problem.

Agricultural innovation system (AIS) is a network of actors (individuals, organizations and enterprises), together with supporting institutions and policies in the agricultural and related sectors, which facilitate the process of agricultural innovation. Policies and institutions (formal and informal) play a key role in shaping the way that the AIS actors interact, generate, share and use knowledge, as well as jointly learn.

Agricultural law enforcement, abbreviated from "agricultural comprehensive administrative law enforcement", refers to the actions of a certain country's agricultural administrative organs that have specific and direct impact on the counterparty's rights and obligations or supervise and inspect the exercise and performance of the counterparty's rights and obligations in accordance with the country's "Administrative Licensing Law" and "Administrative Punishment Law" as the basic law enforcement basis as well as other agricultural laws. It includes the law enforcement of seeds, pesticides, fertilizers, plant quarantine, animal epidemic prevention, breeding livestock and poultry management, veterinary drugs, feeds, fishery, grasslands, agromachinery supervision, agricultural product quality and safety, etc.

Agrifood system is defined as the combination of activities and institutions around the production and consumption of a particular food item. Agrifood system activities include production, storage, processing,

wholesaling and consumption. In addition to these activities, an agri-food system also includes a complex web of institutional and regulatory frameworks that influence those systems (IPES, 2015).

Agroecology is a holistic and integrated approach that simultaneously applies ecological and social concepts and principles to the design and management of sustainable agriculture and food systems. It seeks to optimize the interactions between plants, animals, humans and the environment while also addressing the need for socially equitable food systems within which people can exercise choice over what they eat and how and where it is produced. Agroecology is concurrently a science, a set of practices and a social movement and has evolved as a concept over recent decades to expand in scope from a focus on fields and farms to encompass the entirety of agriculture and food systems. It now represents a transdisciplinary field that includes the ecological, socio-cultural, technological, economic and political dimensions of food systems, from production to consumption. (FAO)

Aquaponics refers to the cultivation of fish and plants together in a constructed, recirculating ecosystem utilizing natural bacterial cycles to convert fish waste to plant nutrition. This is an environmentally friendly, natural food-growing method that harnesses the best attributes of aquaculture and hydroponics without the need to discard any water or filtrate or add chemical fertilizers (Thorarinsdottir, 2015).

Balanced fertilization refers to the application of plant nutrients in optimum ratio and adequate amounts. It is the proper supply of all nutrients (macros and micros) throughout the growth of a crop.

Capacity building is a process whereby people, organizations and society as a whole unleash, strengthen, create, adapt and maintain capacity over time (FAO, 2010). Capacity development is increasingly recognized as a multidimensional and multiactor process that goes well beyond the transfer of knowledge and skills at the individual level and encompasses organizational and institutional dimensions (Pearson, 2011).

Enabling environment is a multifaceted setting within which, the agricultural sector and economy operates, comprising non-distorting and stable policies, adequate provision of public goods, good governance through laws and regulations that are conducive to private-sector economic activity while addressing market failures, and strong and effective institutions through which government measures and actions are operationalized (Diaz-Bonilla *et al.*, 2014). TAP (2016) defined enabling environment of AIS as the set of factors that influence agricultural innovation, but that are controlled by governance, regulatory and policy-making organizational structures other than those directly linked to agricultural innovation. It is important to note that not all factors and

conditions are enabling. Very often the environment is disabling. Factors contributing to this situation must be identified and analysed.

Evaluation refers to the systematic and objective assessment of an ongoing or completed project, program or policy, [and] its design, implementation and results. The aim is to determine the relevance and fulfilment of objectives, development efficiency, effectiveness, impact and sustainability. An evaluation should provide information that is credible and useful, enabling the incorporation of lessons learned into the decision-making process of both recipients and donors. Evaluation also refers to the process of determining the worth or significance of an activity, policy or program (OECD, 2002, p. 21-22).

Evidence-informed policymaking is a discourse or set of methods which informs the policy process, rather than aiming to directly affect the eventual goals of the policy. It advocates a more rational, rigorous and systematic approach. The pursuit of evidence-informed policymaking is based on the premise that policy decisions should be better informed by available evidence and should include rational analysis (Sutcliffe & Court, 2005).

Farmer field days are production-focused, on-farm educational events organized and hosted by the producer in collaboration with agricultural educators. Targeting at beginning farmers, the events often include demonstrations of specific management practices and equipment and/or highlight research methods and results so that they can acquire practical information useful for planning or improving their own operations.

Farmer field school is a group-based experiential learning approach which seeks to empower farmers to learn, understand and make informed decisions. In a farmer field school, groups of farmers meet regularly in the field with a facilitator to observe, talk, ask questions and learn together. Farmer field schools, were first conceived by FAO in the late 1980s as a way of training farmers on integrated pest management (IPM). The approach is now used for a wide range of technical and social topics such as water and sanitation, household livelihood security, marketing, child labor, to name a few. (INGENAES Project, 2015)

Fertilizer utilization rate refers to the percentage of nutrients absorbed by the crops in the current season from the applied fertilizer to the total amount of the nutrients in the fertilizer.

Field trial and field demonstration: Field trial refers to the establishment of plots for experimentation where agricultural test objects like plants are evaluated on the basis of various characteristics and properties. Field trials are often set up and performed in seed, plant protection or fertilization. Field demonstration refers to a long-term educational

activity conducted in a systematic manner in farmers' fields to show the worth of a new varieties, inputs, practices, and technologies.

Impact is the overall and long-term effect of an intervention. Impact is the long-term or ultimate result attributable to a development intervention – in contrast to output and outcome, which reflect more immediate results from the intervention. The concept of impact is close to "development effectiveness". Examples: Higher standard of living, increased food security, increased earnings from exports, increased savings owing to a decrease in imports. (UNDP, 2002, p. 101)

Innovation is the process of putting knowledge into use be it in the form of technology, practice or a particular way of working. The context in which innovation takes place is not static. It evolves, develops, adapts and responds (TAP, 2016). Innovation can be technological, organizational and institutional. Innovation is different from invention in that innovation is a discovery or an idea which becomes available to potential users.

Innovation process is a complex, interactive and unpredictable process, highly influenced by its environment and which is difficult or even impossible to manage. It consists of phases of acceleration, slowdown, and crisis, and involves many back-and-forth interactions between the research community and actions undertaken by its partners until the adoption and implementation of innovations by end-users (Barret *et al.*, 2018).

Innovation system is composed of all the actors who interact to innovate by producing knowledge and mobilizing resources. A first meaning of the term refers to organizations dedicated to innovation (research, education, advisory) and their interactions with other actors. In such a case, one can refer to a national, regional or sectoral innovation system. A second meaning refers to all the actors involved in innovation and their interactions. In this case, there is an innovation system by type of innovation studied (Barret *et al.*, 2018).

Institutional reform is the process of reviewing and restructuring EAS institutions so that they can become more effective, efficient, and adaptive in providing high-quality services, more accountable to their clients, and more supportive of agricultural development and agrifood system transformations**.**

Integrated pest management (IPM) means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop with

the least possible disruption to agroecosystems and encourages natural pest control mechanisms. (FAO)

Monitoring is a continuing function that uses the systematic collection of data on specified indicators to provide management and the main stakeholders of an ongoing development intervention with indications of the extent of progress and achievement of objectives and progress in the use of allocated funds (OECD, 2002, p. 27-28).

Multi-actors agricultural innovation platform (MAIP) is a platform established in farmer communities in rural areas, which links researchers, extension agents, private enterprises and smallholder farmers to spur innovations in agriculture value chain development (Yang *et al*., 2022).

Pest monitoring and forecasting: Pest monitoring means checking the fields, landscapes, forests, or buildings—or other sites—to identify which pests are present, how many there are, or what damage they have caused or are causing. Correctly identifying the pest is key to knowing whether a pest is likely to become a problem and determining the best management strategy. Pest forecasting is the data-supported prediction of future activities of biotic agents, which would adversely affect crop production. The monitoring data on pest population or damage over a long period of time together with other variable factors, which affect the development of pest, may be useful for forecasting the pest incidence.

Pesticide residue refers to as any substance or mixture of substances in food for man or animals resulting from the use of a pesticide and includes any specified derivatives, such as degradation and conversion products, metabolites, reaction products, and impurities that are considered to be of toxicological significance (Encyclopedia of Food and Health, 2016).

Pesticide utilization rate refers to the ratio of the amount of pesticides deposited on the target per unit area to the total amount of pesticides used, that is, the deposition rate. Generally speaking, the whole field crop is regarded as the target, and the part of the pesticide deposited on the crop is regarded as the effective amount.

Pluralistic extension and advisory services are services provided by a range of service providers, approaches, funding streams, and sources of information available to farmers and clients. This model can allow farmers the opportunity to choose the most appropriate extension services and providers for their needs. Collaborating extension service providers could include governments/public systems, private companies, international or domestic non-governmental organizations, non-affiliated community extension workers, or other actors (World Bank, 2012). Governments or public extension systems often serve as facilitators and help coordinate extension actors to deliver services that utilize the relative strengths of

each entity. When pluralistic systems work well, they are well equipped to deal with the diversity of conditions, needs, audiences, and farming systems that make up the agricultural landscape by providing an equally diverse array of services and service providers (Feder, Willett & Zijp, 1999 cit in INGENAES Project, 2015).

Policy environment includes all aspects surrounding policymaking, such as social, economic or political aspects. It is not static, but changes in response to the political and economic circumstances, public concerns or international influences (Paschke *et al.*, 2019).

Policy instruments refers to a set of tools and techniques by which governmental authorities wield their power in attempting to ensure support and effect (or prevent) social change (Borras & Edquist, 2013). There are three main categories of instruments: (1) regulatory instruments, (2) economic and financial instruments, and (3) soft instruments.

Resource management is the process of planning, scheduling, forecasting, and optimizing the entire resource life cycle for successful EAS programme implementation. It helps unleash the maximum potential of each resource, improve return on investment, and beat market volatility.

Seed test is the science of evaluating the quality of seeds to determine their value for planting. The aim is to determine the seeds' physical purity, moisture, germination, other distinguishable variety and so on and thereby enabling the farming community to get quality seeds.

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