Capacity development needs and roadmap

Project title: Statistics from Space: Next-generation agricultural production information for enhanced monitoring of food security in Mozambique

Submitted by: Andy Nelson (Faculty of Geo-information Science and Earth Observation (ITC), University of Twente) and Benedito Cunguara (consultant)

To: International Food Policy Research Institute (IFPRI)

Date: January 2026

Summary

This report integrates an assessment of institutional readiness for Earth observation (EO)-based crop monitoring in Mozambique with a roadmap for sustaining and scaling an EO and digital workflow for agricultural statistics. The aim is to

- Baseline current capacity by systematically evaluating the institutional readiness and willingness within key government organizations to adopt and sustain EO-based systems.
- Identify gaps and risks by pinpointing specific challenges, from technical shortages to policy misalignments, that could prevent the sustained adoption of EO technology beyond a project's life cycle.
- Document actions to maintain or raise the institutional readiness level to ensure the project's desired impact is feasible.

The narrative focuses on what would be required to move from project demonstration to routine production and use, with the Ministério da Agricultura, Ambiente e Pescas (MAAP, formerly the Ministry of Agriculture and Rural Development, MADER) and the Regional Centre of Excellence in Agrifood Systems and Nutrition (CE-AFSN) at Universidade Eduardo Mondlane (UEM, formerly the Centro de Estudo de Políticas e Programas Agroalimentares, CEPPAG) as the main national counterparts and with due recognition of the role of the Instituto Nacional de Estatística (INE).

The readiness assessment highlights that Mozambique has strong potential for EO-enabled agricultural data, but that this potential is constrained by fragmented technical capacity, limited government resourcing for software and computing, a reliance on short-term projects and external consultants, and weak institutional arrangements for data ownership, openness, and inter-agency collaboration. It also identifies governance risks created by outdated foundational baselines that continue to shape policy and sampling design.

The roadmap therefore centres on a staged transition. In the near term, priority lies in formalising mandates, custodianship, documentation, and integration pathways with existing survey and census processes. In the medium term, priority lies in building repeatable operational capability and reducing dependence on a small number of individuals. In the longer term, priority lies in embedding stewardship and financing, updating national baselines on a defined cycle, and using the donor-led Development Partners Group for Agriculture and Rural Development (AgRED) group as a coordination mechanism to align partner support and reduce duplication.

1. Purpose, scope, and audience

The purpose of this report is to set out capacity development needs and a forward roadmap for sustaining and extending an approach that combines EO and digital tools to strengthen agricultural statistics in Mozambique. The scope covers capacity needs at individual, organisational, and institutional levels within mandated ministries and organisations.

The report uses ‘EO’ as an umbrella term for satellite and related remote sensing inputs. It uses ‘agricultural statistics’ to refer to official statistics produced through survey and census systems, including the Inquérito Agrário Integrado (IAI, integrated agricultural survey), the Trabalho de Inquérito Agrícola (TIA, agricultural survey), and the Censo Agro-Pecuário (CAP, agricultural and livestock census). Crop monitoring and early warning systems remain adjacent

functions with shared data needs and field constraints, and coordination with those functions is treated as a practical dependency rather than the primary focus.

The report starts from the following context. (i) Staff resources dedicated to EO activities are minimal and small. (ii) Investments in skill development, enhancement, retention, software, and computational capacity are not currently covered by government funds, but solely by projects and partner support such as Statistics from Space, highlighting a major sustainability risk. (iii) The need for this capacity aligns with national strategic plans, such as PEDSA II and PNISA II, which aim to transform the agricultural sector and sustainably increase production.

2. Country situation and institutional readiness

2.1 Rationale and context

Advances in EO technologies and data analytics provide increasingly cost-effective and rapid alternatives to resource-intensive field activities. With higher-resolution EO data and improved modelling and computing capabilities, it is now possible to monitor crop conditions and generate crop maps even in regions dominated by smallholder farming. A key constraint in many developing countries remains the human and institutional capacity to operationalise these models and integrate the insights into policy and implementation.

In Mozambique, staff resources dedicated to EO activities are minimal in primary agricultural units. Investments in skill development, retention, software, and computational capacity are typically supported by projects rather than domestic budgets, creating sustainability risks. The need for this capacity aligns with national strategic plans, including PEDSA II and PNISA II, that seek to transform the agricultural sector and sustainably increase production.

2.2 Governance, accountability, and decision-making

Agricultural statistics in Mozambique are coordinated primarily between the Ministry of Agriculture, Environment, and Fisheries (MAAP) and the National Institute of Statistics (INE). Coordination is structurally facilitated by the alternating cycles of the Agricultural Surveys (TIA/IAI) and the Census (CAP), allowing the same technical teams to support both efforts. Additionally, SETSAN conducts vulnerability and food security-focused surveys. While these agencies collaborate, lines of accountability for data maintenance are often blurred by heavy external dependency. The operationalization of these surveys relies almost entirely on technical assistance from the FAO and financial backing from the World Bank and the African Development Bank. This creates a "project-based" accountability model where the ministry holds the mandate, but technical stewardship often resides with external consultants, making it difficult for the government to take full ownership of the data-generation process.

The absence of a formal government mandate for Remote Sensing (RS) has led to a significant gap in methodological accountability. This is most evident in the continued reliance in Mozambique of the 36 million hectares estimate of arable land. This estimate has appeared in national strategies since the early 2000s without update or a transparent methodology for its derivation. The fact that a 20-year-old unverified estimate remains the official baseline for PEDSA II and other national strategies reveals a lack of designated institutional responsibility for verifying and updating national land-use data. Without a clear "data owner" held accountable for the accuracy of these figures, outdated estimates continue to drive high-level policy.

A cornerstone of agricultural development is the accurate delineation of Agro-Ecological Zones (AEZs), as interventions – from fertilizer recommendations to irrigation – are targeted based on these classifications. However, Mozambique's current AEZ definitions are largely based on data from the 1960s. Relying on 50-year-old zonation creates a major accountability risk:

- Flawed Sampling Frames: Since the IAI and CAP draw samples based on these obsolete zones, the resulting national statistics may be fundamentally unrepresentative of current realities, leading to misallocated resources.
- Obsolete Foundational Data: The existing zones were defined by the presence of cashew and coconut trees – industries that have since declined or shifted – and climatic patterns from 1969.
- Climate & Demographic Shifts: Ignoring the impacts of climate change and population redistribution since the liberation war means that the government is essentially making modern development decisions based on a landscape that no longer exists.

The failure to update these zones is not merely a technical delay but a governance failure; it prevents the government from being truly accountable to farming communities, as extension services may be delivering "misleading" messages based on outdated environmental data.

Current efforts remain guided by general UN recommendations and isolated research rather than a formalized government mandate. While RS is utilized for early warning (WRSI), it remains siloed and is not integrated into official statistics. Accountability cannot be achieved without transparency and empowerment. The "culture of silence" and informal hierarchies currently prevent technicians from openly sharing and validating data. To ensure that agricultural policies are evidence-based and responsive, EO must be properly institutionalized. This requires a framework that clearly defines data ownership, establishes a regular schedule for baseline updates, and provides a formal mandate for inter-agency collaboration.

Institutional behaviour observed during the readiness assessment indicates an additional barrier: technical staff may be hesitant to share even non-sensitive technical information due to informal approval hierarchies and fear of unauthorised disclosure. This 'culture of silence' points to a need for explicit, high-level mandates that authorise routine inter-agency collaboration, data sharing, and technical validation.

2.3 Technical and operational capacity

The assessment of Mozambique's technical landscape reveals a paradox: significant latent potential exists, but it is hindered by extreme fragmentation and a precarious human resource situation. While dedicated EO expertise within primary agricultural units, such as the National Directorate of Agriculture (DINAG), is currently limited to a few individuals, specialized capacity is distributed across various government "pockets." For instance, the National Center for Cartography and Remote Sensing (CENACARTA) maintains the core technical mandate for satellite imagery, while the FNDS (National Fund for Sustainable Development) operates an advanced MRV unit for land-use monitoring. Similarly, IIAM utilizes GIS within its research departments, and INE employs experienced technicians to maintain the sampling frames for the Agricultural Census. However, because these specialists are scattered across different agencies with varying mandates, there remains a critical shortage of experts specifically trained to apply high-resolution EO analysis to agricultural statistics and food security monitoring.

This challenge is compounded by a systemic lack of harmonized investment in infrastructure and software. There is currently little to no dedicated government budget for high-performance computing or professional software licenses, such as ArcGIS or Stata. Consequently, technical staff frequently rely on personal computers, open-source alternatives like QGIS, or free cloud-processing platforms. This "project-based" approach to technology means that infrastructure is often tied to donor-funded timelines rather than being treated as a permanent institutional asset. When a project concludes, the associated computational resources and software access often lapse, preventing the development of a sustainable, long-term technological foundation.

Furthermore, the absence of a centralized national portal for agricultural data complicates management and accessibility. While Mozambique demonstrates a notable strength in field data collection – leveraging established networks for surveys – this is not matched by an equivalent capacity for post-collection processing. Critical weaknesses persist in data cleaning, advanced spatial analysis, and the routine maintenance of technological infrastructure. Without a centralized system to bridge the gap between field collection and sophisticated EO analysis, the data remains siloed, and the potential for "just-in-time" agricultural assessments remains unrealized.

The sustainability of this capacity is further threatened by a looming demographic and competitive crisis within the civil service. Key departments within MAAP and other institutions have faced hiring freezes, and the Directorate of Planning and Policy is currently facing a "retirement wave." In the Department of Statistics alone – the unit responsible for agricultural surveys and censuses – at least five or six senior technical staff are reaching the compulsory retirement age simultaneously. Filling this technical void is increasingly difficult; the statistical processes involve a steep learning curve that often clashes with a younger workforce's preference for quicker professional payoffs. Moreover, the public sector struggle to compete with the private sector and NGOs, which offer significantly higher wages. This continuous brain drain makes it exceptionally challenging to maintain the institutional memory and technical continuity required for a high-functioning EO system.

2.4 Partnerships and stakeholders

The landscape of EO in Mozambique is defined by a series of fragmented, project-based initiatives rather than a cohesive national framework. Historical efforts, such as the 1998 national land-use map produced by CENACARTA and the more recent 2015 agro-ecological zoning project, demonstrate that high-quality outputs are possible. However, stakeholders characterize these as "isolated initiatives" that lack institutional continuity. Current international collaborations, such as the Cropwatch program – which provides data down to the district level – and initiatives involving the GAF AG group and the UEM-IFPRI partnership, remain the primary drivers of EO activity. While these projects successfully estimate crop areas and monitor conditions, they often operate independently of the official national statistical apparatus.

Despite the potential for resource pooling, inter-ministerial data sharing between MAAP, SETSAN, and INE remains largely ad-hoc and fragmented. This lack of coordination extends to the private sector, where there is currently minimal engagement. Large-scale commercial entities, particularly sugarcane and eucalyptus plantations, utilize sophisticated GIS and EO

tools for internal management and yield optimization. However, these private resources and datasets are not leveraged for public policy or national monitoring. The absence of a structured partnership framework means that the government misses opportunities to incorporate high-resolution private sector data into national food security assessments.

Furthermore, the engagement in international initiatives is often restricted to individual researchers or specific departments rather than being institutionalized at a ministerial level. For example, while researchers at Eduardo Mondlane University (UEM) are deeply involved in international EO research, these links do not always translate into operational capacity within the Ministry. Bridging this gap requires moving beyond "contractor-client" relationships with international partners and establishing a permanent collaborative platform where national institutions, international donors, and the private sector can synchronize their efforts toward a unified agricultural monitoring objective.

2.5 Sustainability beyond donor funding

The long-term viability of EO initiatives in Mozambique currently faces a critical sustainability risk, primarily driven by a deep-seated financial and technical dependency on international partners. National agricultural monitoring, including the large-scale surveys and censuses (IAI/CAP), remains almost entirely reliant on external funding from the World Bank and the FAO. In the absence of a clear national resource mobilization strategy, there is no formal mechanism to secure the domestic budget required to maintain EO activities once specific donor projects conclude. This fiscal gap creates a cycle of intermittent progress where technological advancements are temporary rather than foundational.

A significant bottleneck to institutionalizing these tools is the systemic loss of data and knowledge at the end of project cycles. Because high-level technical tasks – such as advanced data cleaning, algorithm development, and spatial analysis – are frequently outsourced to a select few national and international consultants, the home institutions are often left without the internal capacity to manage, update, or troubleshoot these systems independently. This reliance on a "consultancy model" prevents the accumulation of institutional memory and keeps the Ministry in a position of technical stewardship rather than technical leadership. Consequently, when a project ends, the expertise often leaves with the consultant, leaving behind a capacity void.

Furthermore, while there are pathways to integrate project findings into national frameworks – such as the ad-hoc addition of specific indicators to survey questionnaires – there is a notable lack of a permanent, institutionalized home for these digital assets. This is most evident in the fate of web-based portals and data applications developed during project lifespans; many of these platforms tend to go offline or become obsolete shortly after funding ceases. Without a dedicated government mandate and budget for the routine maintenance of technological infrastructure, EO remains a project-based luxury rather than a sustainable, core function of national agricultural planning.

2.6 Strategic priorities emerging from the readiness assessment

The institutional readiness assessment for EO in Mozambique reveals a landscape of high potential contrasted by structural fragility. While the technical tools and "pockets" of expertise exist to revolutionize agricultural monitoring, the current reliance on intermittent donor funding

and external consultants prevents these tools from becoming a core function of the state. To move beyond the current state of fragmented initiatives and stagnant baselines, the following strategic priorities must be addressed.

1. Formalizing the mandate for data openness

The "culture of silence" and the pervasive hesitation among technical staff represent a primary barrier to operational success. Technical expertise cannot be leveraged if it is locked behind informal approval hierarchies. A successful EO-based crop monitoring system requires an explicit, high-level administrative mandate that not only authorizes but actively encourages inter-agency data sharing and collaborative analysis. This mandate must clarify that sharing routine technical data is a standard operational requirement, thereby removing the perceived administrative risk currently felt by technical staff.

2. Institutionalizing Technical Stewardship

The current "consultancy model" is a significant threat to long-term sustainability. To achieve technical leadership, MAAP and its partners must prioritize the internal retention of knowledge. This involves moving away from outsourcing core analytical tasks and instead focusing on training-of-trainers models that embed EO capabilities within the permanent civil service. Addressing the retirement wave in the Department of Statistics is an urgent priority; the transition of knowledge from senior staff to a new generation of technicians must be formalized before critical institutional memory is lost.

3. Establishing a data-driven accountability framework

The continued use of unverified estimates, some over fifty years old, underscores the need for a new framework of methodological accountability. The government must designate specific "data owners" responsible for the periodic update of national baselines, such as the 36 million hectares of arable land and the national Agro-Ecological Zones (AEZs). By institutionalizing EO as the umbrella for these updates, Mozambique can ensure that its agricultural policies, extension services, and resource allocations are based on the reality of a changing climate and evolving demographic landscape rather than historical artifacts.

4. Moving toward financial self-sufficiency

Ultimately, the transition from EO as a project-based luxury to a core planning function requires a domestic resource mobilization strategy. While international partnerships with the World Bank and FAO remain vital, a phased approach to integrating EO operational costs into the national budget is essential. This will ensure that digital portals, high-performance computing resources, and software licenses do not lapse at the end of project cycles, providing the "just-in-time" insights necessary to ensure national food security in an increasingly volatile environment.

3. Implications for Statistics from Space operationalisation

The Statistics from Space project demonstrated an integrated workflow linking EO-derived stratification and sampling, smartphone-based field data collection, centralised data management, near real-time monitoring, and dissemination of crop statistics and maps. Sustained adoption implies operating this workflow as a repeatable annual cycle, including

maintenance of spatial inputs, disciplined field protocols, and review cycles that enable correction while teams remain in the field.

Project implementation experience also illustrates that resilience is a design requirement. Field coverage can vary by province due to extreme weather and access constraints, and the use of backup sampling areas can improve operational flexibility. Routine production therefore benefits from contingency planning and resourcing that allows repeat attempts where feasible and early identification of coverage gaps through monitoring.

The readiness assessment suggests that successful operationalisation will depend on addressing governance and stewardship barriers alongside technical capability. In particular, the workflow will remain fragile without clear data ownership, clear rules for access and publication, and formal mandates that enable inter-agency collaboration and routine data sharing.

4. Capacity development needs and roadmap

4.1 Capacity development needs

At individual level, the main needs relate to a workforce able to operate the full data lifecycle: sampling design concepts, field protocol implementation, digital tool configuration and testing, geo-referencing and photo protocols, in-field quality checks, and routine analytical validation. The ability to identify tool logic errors early and to act on monitoring information during field campaigns is central to protecting data quality.

At organisational level, the main needs relate to stable workflows and ownership. This includes custodians for platforms and databases, standard operating procedures for preparation and fieldwork, device and user management, and routines for archiving and documentation. It also includes a shift from project-based infrastructure to institutional assets, including hosting arrangements and continuity of access to required tools.

At institutional level, the main needs relate to governance, coordination, standards, and sustainability. This includes formal mandates for EO use and for routine inter-agency collaboration, designation of data owners for key baselines, defined schedules for updating baselines and sampling frames, and data governance arrangements covering access rights and publication. Succession planning and formal knowledge transfer mechanisms are required to mitigate the current human resource risks.

4.2 Roadmap

In the near term, the priority is to stabilise what exists and to make collaboration possible. This includes confirming custodianship for platforms and data assets, consolidating documentation and standard operating procedures, and establishing clear access and publication rules. It also includes securing high-level mandates that authorise routine collaboration and data sharing across MAAP (DPP, DINAG, SETSAN, MRV), INE, CE-AFSN, and other relevant agencies, so that technical staff can engage without formal clearance barriers.

Near-term integration work should define how EO-based strata and sampling areas complement existing survey and census processes. This includes specifying where EO can improve representativeness or efficiency, how digital monitoring strengthens supervision and quality assurance, and how outputs relate to existing IAI, TIA, and CAP production and

dissemination pathways. The aim is to agree a limited set of testable process changes that can be repeated across seasons.

AgRED (Box 1) could be used as a standing forum to align partner support behind a single operational pathway for agricultural data and statistics modernisation. This includes maintaining a shared view of partner-funded activities, reducing duplication, and agreeing a small number of priorities and shared assets, potentially through a dedicated sub-group.

Box 1: What is AgRED?

AgRED's objective is "*to strengthen the overall development effectiveness of support provided to the agriculture sector by harmonizing development partners' interventions and by promoting coordinated and efficient policy dialogue with the Government of Mozambique*." There are over 30 agencies represented in AgRED. The World Bank with GIZ are the current co-chairs. Members include FAO, the EU, AGRA, AfDB, IFAD, USAID, DFID, JICA, SIDA, the Netherlands Embassy and the governments of Austria and Ireland. The group meets monthly and communicates message to the Government of Mozambique monthly.

In the medium term, the priority is to make the workflow replicable under real conditions. This includes establishing a recurring field campaign model with defined supervision and review routines, and contingency options including backup sampling areas and, where feasible, complementary methods such as uncrewed aerial vehicles or other modalities. It also includes institutionalising core technical roles so that operations do not depend on a small number of individuals or consultants.

In the longer term, the priority is to embed sustainability. This includes establishing a regular cycle for updating national baselines and agro-ecological zoning using EO as the umbrella for methodological accountability, integrating core operational costs into domestic budgets on a phased basis, and maintaining a national training pipeline. AgRED has a role in sustaining partner alignment around multi-year priorities and continuity of support, while reducing churn between project cycles.

4.3 Risk and continuity

Continuity risks arise from both field and institutional factors. Field operations are exposed to extreme weather and access constraints, which can reduce sampling coverage and weaken estimates if not addressed through adaptive planning. Routine operations therefore benefit from treating contingency planning, re-planning, and early detection of coverage gaps as standard features.

AgRED can contribute to continuity by helping align partner-supported activities with the agricultural calendar and by reducing competition for scarce field resources during critical windows. It can also support minimum expectations for sustainability and handover across partner-funded work, including early agreement on custodianship, documentation, and knowledge transfer.

Institutional continuity risks include staff turnover, delayed contracting, knowledge loss, and repeated instrument and process errors across cycles. These risks are reduced by institutionalised piloting, documented processes, clear ownership of data systems, and routine feedback mechanisms that embed lessons learned into the next cycle.

4.4 Monitoring, evaluation, learning, and partnerships

Monitoring, evaluation, and learning supports sustained adoption by treating readiness and uptake as measurable and revisitable. This includes readiness assessments that combine narrative evidence with structured scoring, and indicators that track operational outputs and outcome-level change in routine production and use.

Practical checkpoints can be drawn from known failure modes and from workflow design. These include systematic piloting and instrument testing before deployment, near real-time checks of field data completeness and consistency during collection, and verification that data management and dissemination procedures remain stable and documented across cycles.

AgRED can provide a lightweight mechanism for joint monitoring, evaluation, and learning across partner contributions by agreeing a small set of shared questions and indicators and using periodic discussions to review progress and adjust coordination choices. This should be designed to minimise reporting burden on MAAP and CE-AFSN while maintaining visibility on whether partner investments reinforce adoption outcomes.

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Expert Survey (2025) *See Appendix*

Appendix: Questions from the expert readiness assessment survey

#	**Questions**
Governance, accountability, and decision-making	
1	Can you describe the current national coordination mechanism for agricultural statistics?
2	Can you describe the current policies or strategies to guide and promote the use of remote sensing within the ministries and agencies responsible for agricultural statistics?
3	To what extent is remote sensing used in the production of agricultural statistics?
Current technical and operational capacity	
4	What is the number of staff employed and/or dedicated to remote sensing-related activities in relevant departments in the ministries?
5	Are there resources dedicated to skill development, enhancement, and retention?
6	Are there investment in remote sensing analysis software and computational capacity?
7	What is the status of remote sending-based agriculture data portals and applications developed and applied in Mozambique?

8	What is the level of application of remote-sensing-based agriculture data portals and applications developed externally/by international partners?
9	What is the current capacity / infrastructure for data collection and management?
10	Are there data sharing and data management strategies in place?
11	What are the current strengths in terms of skills and capacity?
12	What are the current weaknesses in terms of skills and capacity?
Partnerships and stakeholders	
13	Are there any past national initiatives in remote sensing for agricultural statistics? If so, please briefly describe them and their outcomes
14	Are there any active national initiatives in remote sensing for agricultural statistics?
15	If yes to Q14, What is the level of engagement in these initiatives and activities?
16	What is the level of engagement in international initiatives for the use of remote sensing for agricultural statistics?
17	What is the level of engagement of the private sector in Mozambique in these activities?
Sustainability beyond donor funding	
18	The ministry participates in many donor-funded projects. Typically, what decision-making processes are in place to integrate project outcomes and practices into existing institutional frameworks and national policies?
19	What resource mobilisation strategy is in place to secure the support and resources to continue a project after donor-funded ends?
20	What data and knowledge management strategy is in place to organise and disseminate project knowledge after a project ends?