GOPA MetaMeta

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Kamil Al Rayyes

Reducing Food Loss from Rodent Pests

An Ecological and Scalable Approach

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This position paper presents GOPA MetaMeta's perspective on Ecologically-Based Rodent Management, or EBRM, as a practical and scalable approach to reducing food loss, limiting hazardous chemical use, and strengthening resilient food systems. Rodents are a major but often neglected cause of crop and storage losses, particularly in low- and middle-income countries. Conventional responses frequently rely on hazardous rodenticides, which can pose risks to people, livestock, wildlife and the environment, while often failing to address the ecological drivers of recurring infestations.

Based on more than a decade of applied research and field implementation across Africa, Asia, Europe and the Middle East, GOPA MetaMeta supports governments, development partners, research institutions, farmer organizations and private sector actors to design, test and scale EBRM solutions. These combine ecological knowledge, farmer experience, safe storage, habitat management, monitoring tools, local enterprise development and collective action.

This paper aims to invite collaboration and investment in sustainable rodent management as a core part of agroecology, Integrated Pest Management, food security, public health and climate-resilient agriculture.

The Challenge

Rodents are among the most widespread and adaptable mammals. While they play important ecological roles, a subset of 147 species is recognized as major agricultural and public health pests. They damage crops in the field, contaminate stored food, destroy seed stocks, damage infrastructure and transmit zoonotic diseases. In many smallholder farming systems, losses remain poorly measured and are therefore underestimated in agricultural planning and investment [i].

The hidden impact of rodent pests*

FIELD LOSSES	STORAGE LOSSES	ECONOMIC LOSSES	HEALTH RISKS	CHEMICAL RISKS
9–57%	**10–20%**	**200 million**	**147**	**Widespread**
yield loss in rice fields	of post-harvest food lost	people could be fed	species are major pests	unsafe rodenticide use
In Southeast Asia, rice yield losses average 9%, with catastrophic losses up to 57% in some fields. [ii], [iii]	Post-harvest losses commonly reach 10–20% worldwide. In Africa, combined field and storage losses reach 24%. [iv], [v], [vi]	Rodents contaminate and destroy enough food each year to feed 200 million people — food already grown. [v]	147 rodent species are recognized as major agricultural and public health pests, transmitting zoonoses. [i]	Hazardous metal phosphides and anticoagulants are widely used, risking poisoning, contamination and resistance. [vii], [viii]

** Figures reflect ranges reported in the cited studies (see footnotes i–viii); actual losses vary by crop, region and season.*

Despite this impact, rodent management is often neglected compared to insects, plant diseases and weeds. Where action is taken, it frequently relies on reactive use of chemical rodenticides. In many low- and middle-income countries, hazardous products such as metal phosphides and anticoagulants are widely available and applied by farmers without adequate training or protective measures. This creates risks of accidental poisoning, environmental contamination, harm to non-target species and resistance in rodent populations.

EBRM offers a safer and more durable alternative. It applies ecological knowledge of rodent species, behaviour, habitats and seasonal dynamics to prevent outbreaks and reduce losses through locally adapted combinations of habitat management, safe storage, monitoring, biological and mechanical control, and coordinated community action.

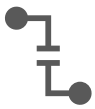
The stakes are high: although estimates vary widely, rodent damage represents a major global economic loss, affecting both food availability and farmer incomes. In many systems, even modest reductions in rodent losses can generate substantial gains because they protect food that has already been produced, harvested or stored.

The four core challenges in rodent pest management

Neglected losses: Rodent damage to crops, seed stocks and stored food is often underestimated and poorly measured. As a result, rodent pests remain under-prioritized in food security strategies, extension systems and agricultural investment.

Chemical dependency and resistance: Many current responses rely on hazardous rodenticides, including metal phosphides and anticoagulants. These can create risks for people, livestock, wildlife and the environment, while repeated use can contribute to resistance and declining effectiveness.

Unintended ecological consequences: Well-intended landscape measures such as vegetation cover, irrigation canals, terraces, hedgerows and soil and water conservation structures can also create food, water and shelter for rodents if pest risks are not considered in design and maintenance.

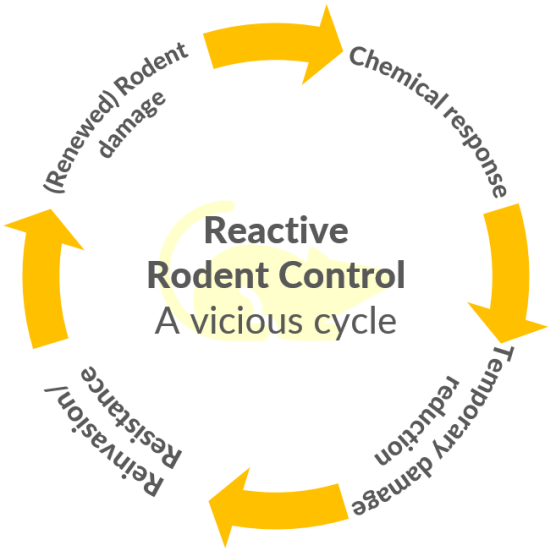


Fragmented responses: Individual or patchy control rarely works because rodents move across fields, storage areas and settlements. Effective management requires coordinated timing, collective action, local governance and shared learning.

A reactive response to a persistent threat: hazardous rodent control

In many low- and middle-income countries, rodent control still relies heavily on hazardous chemical rodenticides. These products are often cheap and accessible, but they are frequently applied by farmers without adequate training, protective equipment or secure baiting systems. This creates risks of accidental poisoning, unsafe residues, contamination of soil and water, harm to non-target species and reduced effectiveness over time.

Field experience from Lebanon illustrates this pattern. In the Shouf region, most surveyed farmers relied primarily on chemical rodenticides, while many considered them only occasionally effective. Farmers described repeated applications at different times of the year and the need to use different products as rodents returned from neighbouring fields. **This underlines a wider lesson: where rodent management remains reactive and individual, chemical control often brings only short-term relief while creating new hazards.**



A proactive perspective: what EBRM changes

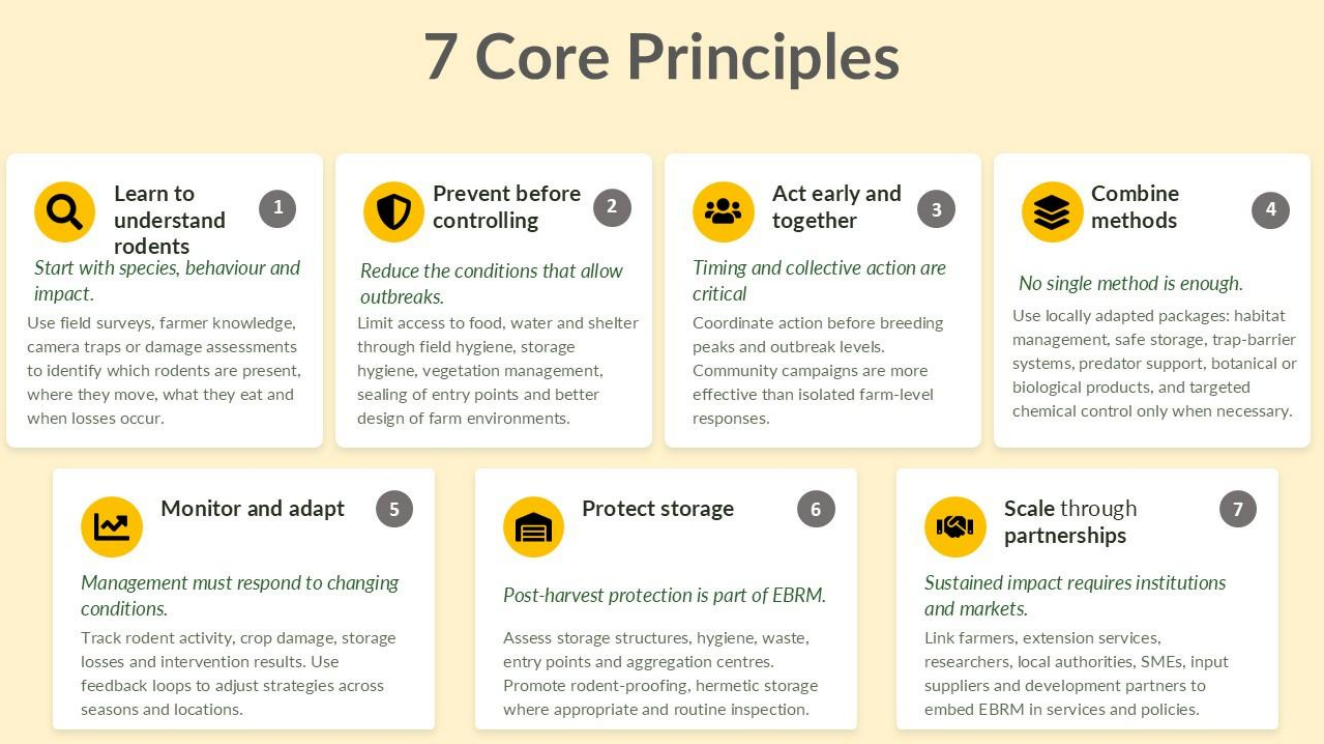
Ecologically-Based Rodent Management (EBRM) **shifts the focus from reacting to outbreaks toward preventing them.** It uses ecological understanding of rodent species, behaviour, habitats, breeding cycles and movement patterns, combined with farmer knowledge, to keep rodent populations below damaging levels.

Rather than promoting one universal solution, **EBRM offers a toolbox of methods** that can be adapted to different crops, seasons, landscapes and storage systems. These include habitat management, field hygiene, safe storage, rodent-proofing, monitoring, trapping, trap-barrier systems, biological and botanical options, encouragement of natural predators and carefully controlled chemical use only as a last resort.

When locally-driven and well-coordinated, EBRM can reduce crop and storage losses, limit hazardous chemical use, support food quality and strengthen agroecological resilience.

Seven principles for sustainable long-term rodent management

GOPA MetaMeta's approach to EBRM is built around seven core principles. Together, these principles move rodent management away from reactive chemical control towards a preventive, adaptive and locally owned approach that protects food, health and ecosystems.



1. Learn to understand rodents

Effective rodent management starts with understanding the local rodent system. This means identifying which species are present, how they behave, where they shelter, when they breed, how they move through fields and storage areas, and what damage they cause. Field surveys, farmer knowledge, camera traps, trapping data and damage assessments help build this picture. This diagnostic step is essential: without knowing the rodent species, their ecology and the timing of losses, interventions risk being poorly targeted, ineffective or even counterproductive. By combining scientific methods with local knowledge, communities and experts can design management strategies that are practical, safe and adapted to local conditions.

Field experience 1 – Ethiopia: From Rodent Ecology to Bio-Based Innovation

In Ethiopia, GOPA MetaMeta and partners have advanced EBRM through research and collaboration. Field studies in the Amhara region began by identifying four botanicals that farmers were already using to control rodents, for instance by placing these plants directly in front of active rodent burrows. However, there was no ready-made product available to farmers. More generally, it remains very difficult to access non-chemical rodent management products in the region. Therefore, we initiated a study to develop a 100% plant-based rodenticide based on the four ingredients farmers were already using.

To do this, we ran laboratory and field trials in parallel. Laboratory trials were conducted with wild-caught rodents under the guidance of Ethiopian rodent experts. These tests assessed efficacy, palatability, optimal dosage, and safety for non-target animals. The research showed that certain botanical mixtures had a synergistic effect, making them both palatable and highly effective. Palatability trials helped refine bait formulations based on farmer preferences, while safety tests with chickens and guinea pigs confirmed environmental soundness. In the field, we placed camera traps to capture rats' behavioral responses to newly deployed plant-based bio-rodenticides.

A key difference with the bio-rodenticide is its delayed sickening or lethal response, which makes it very different from the acute chemical poisons on the market. With acute rodenticides, rodents can associate feeling unwell with the poison and avoid taking it again. However, when the effect only begins after 48–72 hours, it becomes difficult for rodents to trace the response back to the bait. This delayed effect is an important benefit of the bio-rodenticide, in addition to its volatility, which makes it easily degradable and not harmful to the environment or non-target species.

Women-led SMEs were trained to prepare and apply the bio-rodenticide, making the solution accessible and practical. Farmer feedback and peer learning supported adoption, with significant reductions in rodent losses reported.

Figure 1: Camera trap installation (left); women-led SME training on bio-rodenticide preparation and application (right) (Photo Credit GOPA MetaMeta)

This research-driven, participatory approach was recognized with the 2021 OLAM Food Prize, highlighting its impact on sustainable food systems.

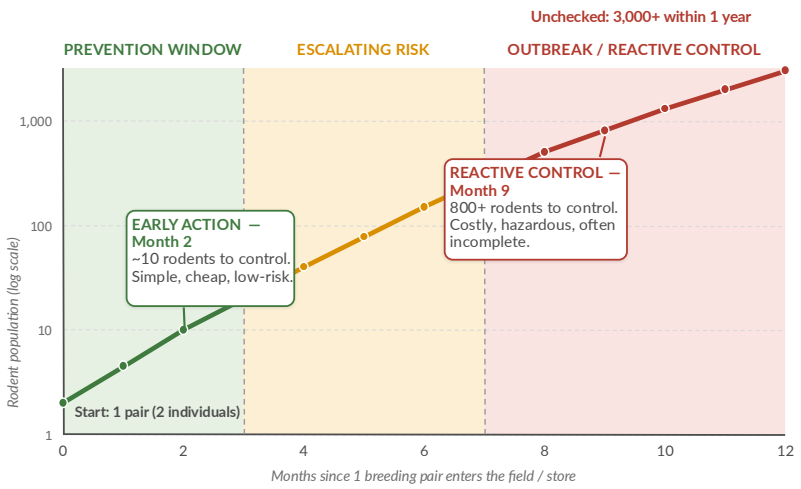
2. Prevent before controlling

Prevention is the first line of defense in EBRM and forms the foundation of the Integrated Pest Management cascade. The aim is to reduce the conditions that allow rodent populations to grow before they reach damaging levels. This means limiting access to food, water, shelter and nesting places through practical measures such as field and storage hygiene, vegetation management, sealing entry points, improving storage structures, managing bunds and field margins, and reducing spilled grain or waste.

In an EBRM approach, control does not start with poisoning or trapping. It starts with making the farming, storage and landscape environment less favourable to rodents. This is especially important under climate variability, as rodent populations can increase rapidly after rainfall, crop failure or changes in land and water management. Early warning, participatory monitoring and community mapping can help identify risk areas before damage becomes severe.

Why Prevention Matters

How early action stops an exponential rodent outbreak before it starts



Species basis: ***Apodemus mystacinus***
Broad-toothed field mouse — a principal rodent pest reported in Lebanese farming systems (see Shouf field experience, p.5). Typical biology: gestation ~23–26 days; 3–4 litters/year; ~4–5 young/litter.

Curve assumes continuous, unmanaged breeding from a single pair — illustrative of outbreak potential, not a field forecast.

The prevention logic

~10	~800
rodents to remove if you act in month 2	rodents to remove if you wait until month 9

Roughly 80× more animals to control after only 7 extra months of inaction .

Why prevention matters (EBRM Principle 2)

- Prevention is the foundation of the EBRM / IPM cascade — limit food, water, shelter and nesting sites before populations grow.
- Populations can climb sharply after rainfall, crop failure or land/water changes — early warning and monitoring matter.
- Acting early keeps rodents below damaging thresholds and reduces the need for emergency, hazardous chemical control.

The earlier you act, the fewer rodents you need to control — and the more food you save.

By embedding prevention into everyday farming, storage, irrigation and landscape management practices, EBRM reduces the need for emergency control and helps keep rodent populations below damaging thresholds. When prevention alone is not sufficient, additional control measures can be layered step by step, as described under Principle 4.

3. Act early and together

Timing and collective action are critical. Rodent populations can grow rapidly, so interventions are most effective when implemented before breeding peaks and before crop damage becomes visible at scale. Individual farmers acting alone often have limited impact because rodents move across fields, irrigation canals,

field margins, settlements and storage areas. Community-level action is therefore essential. Coordinated campaigns, shared monitoring, synchronized field operations, joint trapping, cleaning campaigns and collective storage improvements can prevent reinfestation and reduce losses across a wider landscape. Local committees, extension workers, farmer groups and champion farmers play a key role in organizing this collective response.

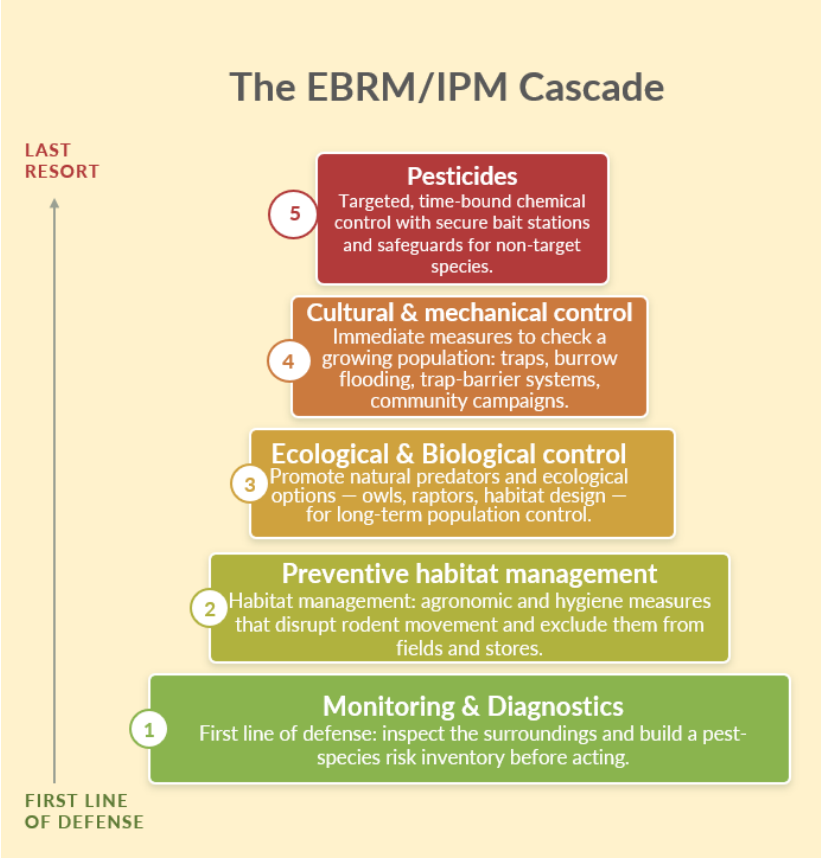
Field experience – Ethiopia: Scaling EBRM through Watershed Campaigns and Rodent-Safe Storage

In Ethiopia's Amhara region, rodents have long caused major crop and pasture losses, a problem often overlooked until large-scale watershed rehabilitation inadvertently created new rodent habitats. The turning point came with integrating EBRM into community watershed campaigns. Through participatory trainings, routine campaigns, and the inclusion of rodent management in extension and watershed programs, communities shifted from isolated efforts to a systematic, collective approach. A key lesson has been the importance of carrying out rodent management in a timely manner during the lean season, when food is scarce, rodent populations are more vulnerable, and coordinated action can prevent numbers from building up before the main cropping season.

Today, over 350 watersheds, covering nearly 175,000 hectares and benefiting around 70,000 households, regularly organize EBRM activities. These include cleaning storage areas, improving field cultivation, maintaining conservation structures, and coordinating trapping campaigns, all led by watershed user committees and champion farmers. By prioritizing these actions during the lean season, communities can reduce rodent pressure before crops are planted or reach vulnerable growth stages, making management more effective and less costly.

Figure 2: Rodent management campaign by a watershed committee in Amhara region, Ethiopia (Photo Credit GOPA MetaMeta)

4. Combine methods



No single method is sufficient on its own. Sustainable rodent management requires a locally adapted combination of measures, selected according to the rodent species, season, crop cycle, storage system, landscape and level of infestation. This is where EBRM applies the full Integrated Pest Management cascade: start with diagnosis and prevention, then move gradually towards more direct control measures only when monitoring shows they are needed.

The cascade begins with understanding the rodent system: which species are present, where they live, when they breed, how they move and where losses occur. Prevention then forms the base: reducing access to food, water and shelter through hygiene, storage improvements, vegetation management, field design and maintenance of bunds, canals and conservation structures. These are the lowest-risk measures and should always remain part of the management package.

When rodent pressure remains high, ecological and mechanical control measures can be added. These may include encouraging natural predators such as owls, raptors, foxes and mongooses; using traps; installing trap-barrier systems; flooding or closing burrows; and applying botanical or biological products where appropriate. These methods directly reduce rodent pressure while minimizing risks to people, livestock, wildlife and the wider environment.

Chemical rodenticides should be treated as a last resort, not as the default response. They may be considered only when other measures are insufficient, for example during severe outbreaks, and must be applied under strict safety conditions. Baits should be placed in secure bait stations accessible only to target rodents, and highly hazardous products should be avoided wherever safer alternatives exist.

The optimal mix of methods changes throughout the year. Before planting, communities may focus on burrow mapping, habitat management and synchronized land preparation. During crop growth, monitoring, predator support, trapping and barrier systems may be prioritized. Around harvest and storage, attention shifts to hygiene, rodent-proof storage, safe aggregation and routine inspection. In this way, EBRM becomes a seasonal management strategy aligned with the agricultural calendar, rather than a one-off control campaign.

Field experience – Lebanon and Central India: Co-Designed Toolkits for Local Rodent Problems

In Lebanon's Shouf region, farmers and local partners established Communities of Practice to design and test EBRM toolkits suited to a mosaic landscape of terraces and mixed crops. Together, they tested snap traps, cage traps, bait stations, gypsum powder, improved hygiene and safe storage. In Bater, a Linear Trap Barrier System was constructed from upcycled materials with community labour. Trapping missions with local ecologists used Capture-Mark-Recapture methods to monitor rodent populations before and after interventions. The combined EBRM methods substantially reduced rodent activity and crop damage, demonstrating that ecological approaches can match chemical control while avoiding many environmental risks.

Figure 3: The EBRM community of practice in Lebanon testing different EBRM approaches in a polyculture agricultural system (left, center), and the Capture-Mark-Recapture method for monitoring (right) (Photo credit GOPA MetaMeta)

In Central India, farmers combined long-standing local practices, such as smoking and flooding burrows, hunting and local trapping, with community-driven monitoring. In seven villages, 125 farmers mapped and sealed more than a thousand rat burrows, then tracked which ones reopened. This shifted rodent management from an individual burden to a coordinated community responsibility. Preventive measures such as synchronized sowing and narrowed bunds were introduced, resulting in fewer active burrows, reduced crop damage and average savings of ₹700–1,200 per farmer in one season.

Figure 4: Deployment of the Linear Trap Barrier System (LTBS) in Lebanon (left), and plugging of rodent burrows by women farmers in Ethiopia (right) (Photo credit GOPA MetaMeta)

5. Monitor and adapt

EBRM is not a one-off intervention. It requires regular monitoring and adjustment as conditions change. Rodent activity, crop damage, storage losses, burrow openings, trap results, farmer observations and seasonal risk factors should be tracked over time. Monitoring allows communities and programme teams to identify hotspots, evaluate what works, and adjust strategies before losses escalate. Feedback loops are essential: farmers, extension workers, researchers and local authorities need practical ways to review results and decide what to change. Digital tools, remote monitoring devices and participatory mapping can strengthen this process, but the key principle remains the same: management must respond to evidence from the field.

Field experience – MED4PEST: Smart Monitoring for Adaptive Rodent Management

The MED4PEST project is developing new ways to support EBRM in Mediterranean agriculture by combining farmer knowledge with advanced monitoring technology. At the centre of the project is ***SPYCE****, an open-source Remote Monitoring Device designed for continuous, non-intrusive surveillance of rodent activity in fields and greenhouses.*

SPYCE uses a modular set of sensors, including infrared cameras, ultrasonic microphones and radar, to collect data on rodent behaviour without disturbing the ecosystem. Deployed in pilot sites in Greece, Turkey and Morocco, the device helps farmers and researchers identify rodent hotspots, monitor population trends and adapt management strategies in real time.

The project goes beyond technology. It combines farmer surveys, field observations and data analysis to connect local knowledge with scientific practice. By integrating remote monitoring into EBRM, MED4PEST supports more precise and preventive interventions, reducing reliance on chemicals and improving the timing and targeting of control measures.

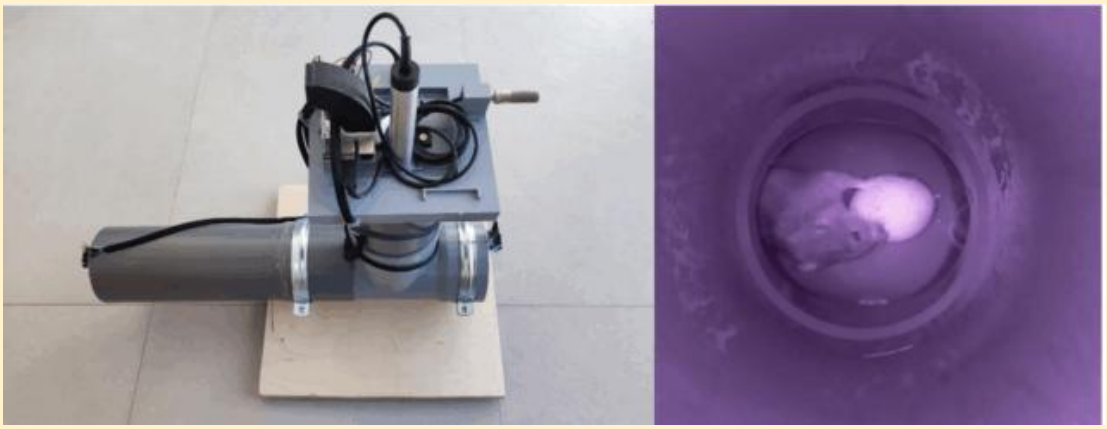


Figure 5: SPYCE device developed in MED4PEST (left); image of rodent activity captured by SPYCE (right). (Photo credit: HMU)

6. Protect storage

Post-harvest protection is a core part of EBRM. Rodents do not only damage crops in the field; they also eat, contaminate and reduce the quality of stored food. Effective storage management requires attention to the whole storage environment: building design, hygiene, waste, entry points, cracks, ventilation, surrounding vegetation and aggregation practices. Practical measures include regular cleaning, removing spilled grain, sealing gaps, using rodent-proof materials, elevating or protecting storage containers, and introducing hermetic or improved storage technologies where appropriate. Storage protection can be applied at household level, cooperative stores, aggregation centres and food value chains. By reducing post-harvest losses, farmers and supply chain actors protect food that has already been produced, harvested and transported.

Field experience – across Africa: Community-Led Storage and Hygiene Solutions

Across several African contexts, GOPA MetaMeta and partners have supported community-led approaches to strengthen storage and hygiene as part of post-harvest rodent management. In Ethiopia's Amhara region, this has included both improved storage practices and locally developed storage innovations. Traditional granaries and sacks are often highly vulnerable to rodent attack, but farmers and local carpenters have developed upgraded corrugated iron grain stores with smooth, vertical walls that rodents cannot climb or chew through. These structures help prevent rodents from accessing stored grain, while also creating local skills and job opportunities for carpenters. Combined with routine cleaning, sealing of entry points, safe placement of stores, and basic hygiene practices, these improvements reduce infestation risks and help protect food quality and household food security.

Urban experiences further underscore the importance of community engagement and participatory approaches. In cities such as Niamey in Niger, Cotonou in Benin, Antananarivo in Madagascar, and Wolaita Sodo in Ethiopia, rapid growth and informal settlements create ideal conditions for rodents. Local committees, youth groups, and researchers are mapping hotspots, organizing cleaning campaigns, and co-designing solutions to break the cycle of infestation and disease.

These examples show that storage and hygiene are not only technical issues. They require community ownership, routine inspection, timely action, and practical local solutions that fit people's daily realities.

Figure 6: Improved grain storage in Ethiopia (left); Community rodent mapping campaigns in Madagascar (right) (Photo credit GOPA MetaMeta and SCARIA)

7. Scale through partnerships

Sustained impact requires partnerships. EBRM is most effective when farmers, extension services, researchers, local authorities, SMEs, input suppliers, public health actors and development partners work together. Each actor brings a different role: farmers provide local knowledge and implementation capacity; researchers support diagnosis and evidence; authorities integrate EBRM into extension and policy; SMEs provide tools and services; and development partners help scale successful models. Knowledge exchange, peer learning and communities of practice are essential for adapting methods to new contexts. Scaling EBRM is therefore not only about transferring technologies; it is about building systems that continue to learn, finance, deliver and improve ecological rodent management over time.

Field experience – Senegal River Valley: Regional Training and Field Experimentation for Scale

In the Senegal River Valley, rodents are a persistent threat to rice and horticulture, with serious implications for food security and farmer income. In 2024, a two-week training brought together 37 participants from Senegal, Mauritania, Mali and Niger, including crop protection agencies, farmer unions, research institutes and private sector actors. The training, supported by the Orange Knowledge Programme and led by MetaMeta with regional partners, combined technical learning with practical field experimentation.

Figure 7: Field experimentation in horticulture in Senegal (Photo credit GOPA MetaMeta)

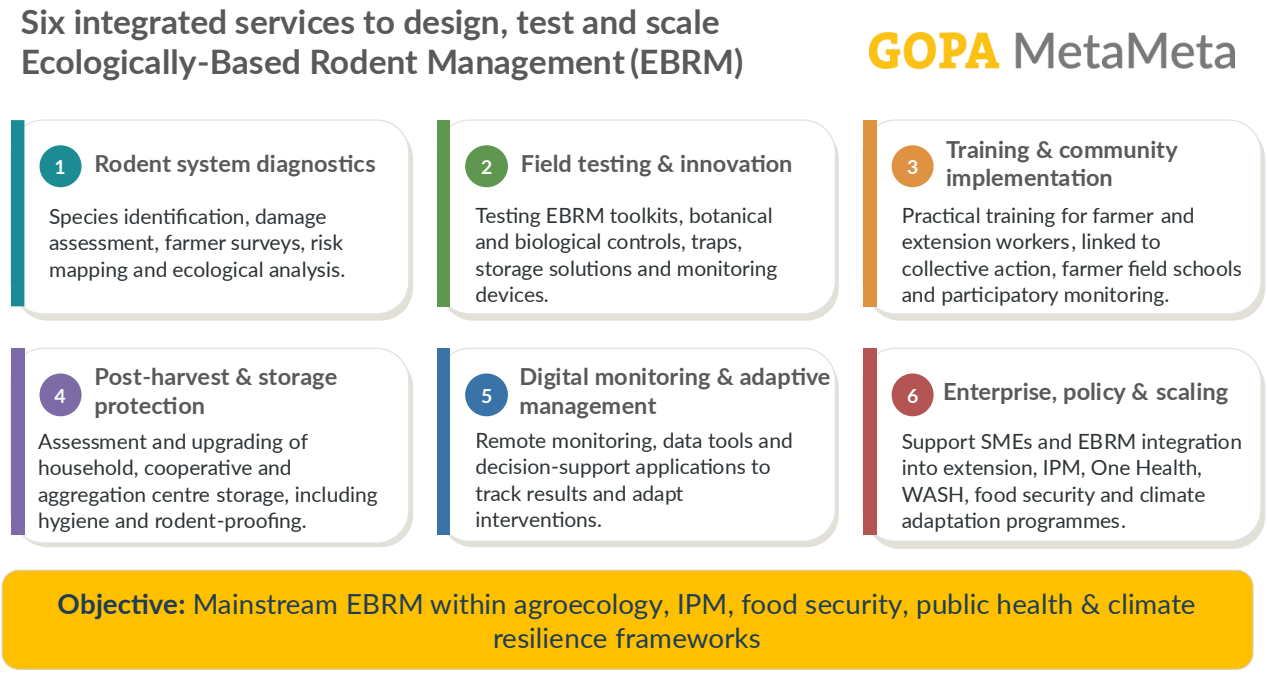
Participants studied rodent ecology, health risks and EBRM principles, then applied these methods in the field. Activities included monitoring rodent presence, building bird perches, implementing Clean-Water-Remove practices and testing Linear Trap Barrier Systems. Community engagement was central, with theatre and peer-to-peer learning used to share knowledge with local farmers.

Collaborative experiments were also implemented in rice and horticulture fields. In rice, Linear Trap Barrier Systems and mechanical control methods, including burrow flooding and beating, were tested with farmers. In horticulture, affordable barrier systems made from plastic sheeting were trialed on peanut, cucumber and onion plots. The Senegal experience shows how regional training, institutional partnerships and field experimentation can create a foundation for scaling EBRM across countries and farming systems.

Figure 8: Practical session on ecological rodent control methods during the multi-stakeholder regional West-Africa training hosted in Saint Louis, Senegal (Photo Credit GOPA MetaMeta)

GOPA MetaMeta's service offering

GOPA MetaMeta supports partners to design, test and scale Ecologically-Based Rodent Management as part of agroecology, Integrated Pest Management, food security, public health and climate resilience programmes. We work in a pragmatic and modular way with organisations that complement our expertise, extend our reach, and help translate the approach into local or sector-specific contexts. Our partnerships are built around clear roles, shared learning, and a common focus on scaling what works while preserving the quality and coherence of the core offer. The service offering below summarises the main ways in which GOPA MetaMeta can support partners across the full cycle from diagnostics and innovation to implementation, enterprise development and policy integration.



Towards future-proof rodent pest management

Rodent pests will remain a growing challenge as food systems face climate variability, land-use change, urbanisation and pressure to reduce hazardous chemical inputs. EBRM provides a practical pathway to manage this risk by combining ecological insight, local knowledge, safe technologies, coordinated action and adaptive learning.

GOPA MetaMeta has experience across Ethiopia, Uganda, Madagascar, Senegal, Niger, Benin, Morocco, Lebanon, India, Nepal, Turkey and Greece, covering a wide range of agricultural, storage and urban systems. Our approach cross-fertilizes practices between regions while tailoring solutions to local realities.

We are ready to work with partners to launch new pilots, strengthen evidence, build local capacity and scale EBRM in regions where rodent losses remain high and current management practices fall short. Together, we can protect harvests, reduce hazardous chemical use, improve public health and build more resilient food systems.

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