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Designing Methods and Evaluation Frameworks for Assessing Scaling Pathways in Crop Diversification and Mechanization Bundles within the Maize Commercialization Model (MCM) in Nepal

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Acronyms

ADB	Agriculture Development Bank
AoW	Areas of Work
AKC	Agriculture Knowledge Centre
BMP	Best Management Practices
CoA	Coalition of Actors
CCDABC	Centre of Crop Development and Agriculture Biodiversity Conservation
CGIAR	Consultative Group for International Agricultural Research
DoA	Department of Agriculture
FAW	Fall Army Worm
GEYSI	Gender Equality and Social Inclusion
GIS	Geographical Information System
MCM	Maize Commercial Model
MoALD	Ministry of Agriculture and Livestock Development
NSAF	Nepal Seed and Fertilizer Project
R&D	Research and Development
USAID	United States Agency for International Development
ZT	Zero Tillage

Executive Summary

This report presents a practical framework for assessing scaling readiness, scaling processes, and system-level outcomes of the Maize Commercialization Model (MCM) in Nepal. MCM is a bundled innovation approach designed to expand spring maize production by combining improved technologies with agronomic training, mechanization access, pest and disease management, institutional strengthening, and coordinated market linkages. Its core objective is to address long-standing constraints in the maize value chain by linking farmers, cooperatives, municipal agencies, traders, and feed mills into a functional commercialization network. The model acknowledges that hybrid maize adoption – the major component of most ongoing research-and-development (R&D) interventions in maize production systems of Nepal – alone is insufficient to improve productivity and farmer incomes; complementary innovations such as nutrient management, mechanization, aggregation, and buyer coordination are essential for sustained impact.

Evaluating bundled innovations differs fundamentally from evaluating individual technologies because bundles generate synergies and interaction effects that only become visible when the system, the actors, and the enabling environment are assessed together. This makes the bundle – rather than any single component – the appropriate unit of analysis for scaling assessments. This report proposes a structured methodology for understanding how such bundles scale in real settings. The first step involves defining core and complementary components and identifying enabling actors and functions. The second step focuses on tracking scaling processes by monitoring adoption patterns, actor coordination, expansion pathways, and enabling environment adjustments. This step also consists of assessing system-level outcomes such as productivity, income, gender inclusion, cooperative performance, and market integration. The final step positions the scaling framework for direct use by government agencies, cooperatives, private-sector partners, and CGIAR teams. The approach aligns closely with CGIAR's Scaling for Impact (S4I) program, ensuring that MCM and similar bundled innovations can be embedded within national systems, partner-led scaling pathways, and broader portfolio-wide learning.



Photo: Dipak Kafle, CIMMYT

1. Introduction

Technological change is central to agricultural transformation, but individual technologies rarely deliver impact on their own. Farmers benefit most when innovations are bundled – when improved seeds are combined with good agronomy, timely mechanization, advisory support, and reliable market arrangements. Such bundles address multiple constraints simultaneously and create stronger, more durable gains than single interventions (Vanlauwe et al. 2014; Boucher et al. 2020). Against this background, this note presents practical design methods and evaluation frameworks for assessing the scaling readiness, scaling processes, and scaling outcomes of the Maize Commercialization Model (MCM) in Nepal. MCM is an integrated, bundled innovation approach introduced to expand spring maize production by combining improved technologies with strong institutional and market support (Choudhary et al. 2023). It brings together hybrid seed use, best-management agronomy training, mechanization access, pest (e.g., fall army worm) management, and digital advisories, while strengthening cooperatives, municipal agencies, traders, and feed mills to create a coordinated production–marketing network. Implemented in districts with spring fallows and good irrigation potential, the model trains farmers with clear inclusion of women, improves technical knowledge, ensures timely input delivery, and links producers with reliable buyers at better prices. By packaging technologies with extension, market linkages, and local institutional strengthening, MCM has the potential to increase crop yields, improve income opportunities, and enable smallholders (both male- and female-headed households) to participate more equitably in maize commercialization.

Assessing the scaling readiness, scaling processes, and system-level outcomes of bundled innovations is important because these interventions rely on interactions among technologies, institutions, and market actors that must progress together for impact to be sustained. MCM provides an innovative case and useful example for developing such an assessment framework, as it brings together multiple innovations and institutional arrangements that operate across the value chain. Using MCM as a model allows us to generate a practical framework that can guide other projects facing similar challenges. Given this complexity, it is essential to establish a clear and workable approach for tracking how bundled innovations advance along scaling pathways – from initial readiness, through adoption and coordination processes, to broader system-level changes that reflect successful scaling.

The present report, therefore, outlines a methodological approach for developing scaling evaluation frameworks that can assess how crop diversification and mechanization bundles evolve along different scaling pathways. Unlike the evaluation of standalone technologies, which can often be assessed in isolation, evaluating bundles requires understanding how technologies, practices, institutions, and market functions reinforce each other. Bundles generate synergies – for example, the impact of hybrid seeds depends on timely mechanization, good agronomy, and stable buyer linkages – but these synergies also create challenges for attributing outcomes to individual components. The framework presented here addresses these issues by treating the bundle as the unit of analysis and examining both the readiness of each element and the combined readiness of the system that supports scaling. It is designed for direct use by government partners, cooperatives, private-sector actors, and CIMMYT/CGIAR teams, and aligns with the CGIAR Scaling for Impact (S4I) Program to ensure integration into country-led scaling efforts. Against this background, the objectives of the report are the following:

- To develop a clear approach for defining the core and complementary components of crop diversification and mechanization bundles, and for identifying the enabling actors and functions required to support them.
- To outline practical methods for tracking scaling processes by monitoring adoption patterns, actor coordination, expansion pathways, enabling-environment adjustments, and key system-level outcomes such as productivity, income, gender inclusion, cooperative performance, and market integration.
- To position the resulting scaling framework for direct use by government agencies, cooperatives, private-sector partners, and CGIAR teams, ensuring full alignment with the CGIAR S4I program and its partner-led scaling pathways.

The report is organized as follows. Section 2 presents the background, including the MCM innovation bundles, the scaling context, and the overall methodological approach. Section 3 addresses Objective 1, outlining how the bundles are characterized and positioned as integrated innovation packages. Section 4 addresses Objective 2, detailing the methods used to assess scaling readiness, scaling processes, and system-level outcomes. Section 5 addresses Objective 3, explaining how these frameworks can be used by partners and aligned with CGIAR's S4I program. Section 6 concludes the report.

1.1 Background: MCM Innovation Bundles, Scaling Context, and Methodological Approach

Nepal faces a significant gap between its growing demand for maize and domestic production capacity. Maize is a strategic crop for Nepal's food and feed systems, constituting roughly half of all poultry feed ingredients. With an estimated 4,500 tons of poultry feed consumed daily, feed demand has been rising by about 10% per year, far outpacing the 2.5% annual growth in maize production (Woli 2024). This imbalance has turned Nepal into a major maize importer, spending over \$100 million each year to meet feed industry needs (imports were projected to exceed \$130 million in 2022). Recognizing this challenge, the Government of Nepal's Agriculture Development Strategy (2015–2035) identified maize as a key commodity for commercialization. However, past efforts to boost domestic maize have been hindered by low farm productivity, inferior grain quality, and fragmented value chains from seed to market. These issues, coupled with inefficient market mechanisms, made it difficult for farmers to pursue maize as a profitable, commercial enterprise. In response, CIMMYT and partners initiated the MCM – an innovation bundle approach designed to close the yield gap and strengthen Nepal's maize value chain. The MCM initiative was implemented as action-research between 2020 and 2024 in pilot regions, demonstrating how coordinated public-private efforts can drive up maize production, improve farmer incomes, and enhance service delivery. This section provides background on the MCM innovation bundles and scaling context, outlines the implementation approach, examines enabling environment factors and key actors, and describes the methodological approach used to assess scaling of this bundled innovation.



Source: <https://staging.cimmyt.org/blogs/building-a-sustainable-hybrid-seed-market-system-in-nepal-to-enhance-food-security-and-farmers-profitability-transforming-the-seed-sector-through-local-capacity-development/>

1.2 MCM Innovation Bundles

The MCM is built on the principle of bundling complementary innovations – technological, organizational, and institutional – to achieve sustainable scaling. Rather than introducing a single improvement in isolation, the MCM package integrates technological innovations (such as high-yielding hybrid maize seeds, mechanized planting and harvesting, and improved agronomic practices) with institutional and market innovations (such as public-private partnerships, cooperatives' input aggregation, credit/insurance services, and marketing arrangements). This “seed-to-feed” model explicitly links on-farm production improvements with downstream market demand in the feed sector. By fostering public–private–farmer partnerships, the MCM bundle addresses multiple constraints concurrently – ensuring farmers have access to quality inputs and know-how, while also creating reliable outlets for their maize produce. Please see Figure 1.

A core element of the innovation bundle is the introduction of improved maize varieties/hybrids and crop management practices. Beginning in 2020, CIMMYT and national research partners deployed new hybrid maize seeds suited to Nepal's environments, alongside training in optimal agronomy (timely planting, proper fertilization, and pest management). These technical innovations have been coupled with value chain innovations – for example, organizing farmers into groups or cooperatives to bulk their harvest, which improves their bargaining power and enables consistent grain quality. Simultaneously, service innovations were introduced, including local provision of mechanization (e.g. precision maize planter, threshers, etc) and digital advisory services to support farmers' decisions. More importantly, the MCM bundle also incorporates market linkage innovations: it facilitates contractual arrangements between producer groups and poultry feed mills and establishes grain collection points, so that increased production can directly translate into sales. By combining these innovations, the MCM initiative creates a synergistic package – farmers are more willing to adopt improved seeds and invest in maize when they are supported by training, organized in networks, and assured of a profitable market for their output.

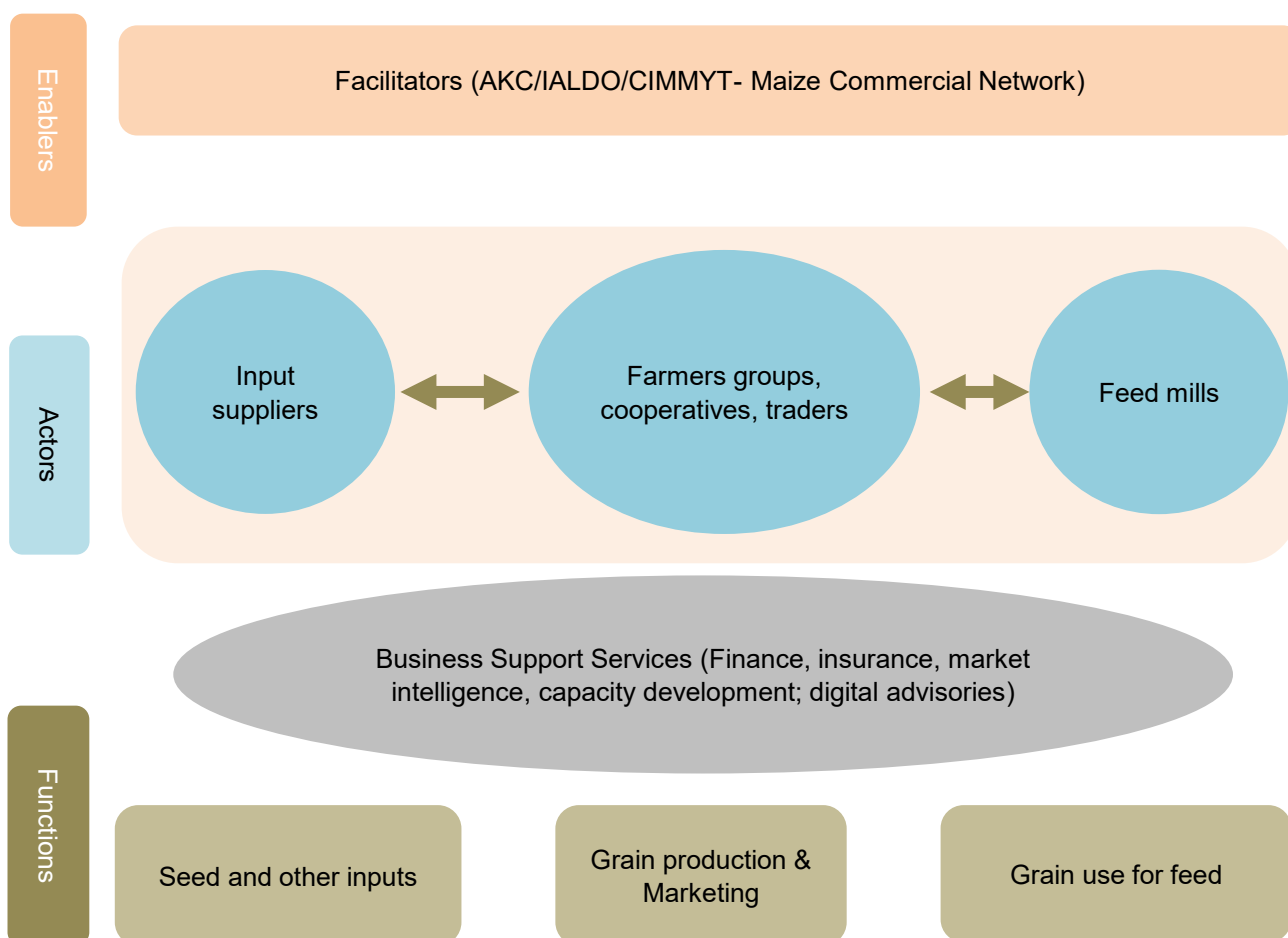


Fig. 1: Actors, Functions, and Enablers in MCM

1.3 Implementation Approach

The implementation of MCM in Nepal followed a coordinated, phased approach, focusing on high-potential scaling sites and leveraging multi-stakeholder collaboration. The initiative was launched in December 2020 under the ongoing NSAF project, targeting spring-season maize cultivation in the Terai region. Large areas of Terai farmland typically lie fallow after the winter crops such as rapeseed and potato; the MCM team identified this as an opportunity to expand maize production, with experts estimating that utilizing these fallow spring lands could substitute about 40% of Nepal's maize imports.

Pilot Sites and Phased Scaling: In early 2022, the MCM was piloted in three districts – Banke, Bardiya, and Kailali – located in Lumbini and Sudurpaschim provinces. These sites were selected for their suitable agro-climatic conditions and proximity to feed industry demand. CIMMYT researchers partnered with local government bodies and private firms to roll out the model in these areas. The approach was incremental: start with a core group of motivated farmers and supportive institutions, demonstrate success, and then expand coverage. By the end of the 2025 cropping cycle, the pilot had engaged over 8,500 farming households across 27 municipalities, covering 2000 hectares under spring maize. This represented a 61% increase in the number of farmers and a 52% increase in maize area compared to the previous year – clear evidence that the innovations were scaling beyond initial demonstration plots.

Public-Private Partnerships and Networks: A hallmark of the implementation was the creation of Maize Commercialization Networks at the provincial and local levels. These multi-stakeholder platforms brought together all key actors – farmers, cooperatives, seed suppliers, agro-dealers, credit providers, extension officers, and feed mill buyers – to plan and coordinate the maize season. By establishing a forum for regular interaction, these networks helped align production with market requirements and ensured farmers could access necessary support services. For instance, through network meetings, farmers learned the volume and quality of grain the feed mills required, and feed companies gained confidence in sourcing from local producers. Provincial governments played a facilitating role by officially convening these networks, signalling high-level support for commercial maize expansion. Working through such partnerships, the MCM implementation team also organized farmer field days, exposure visits, and on-site training sessions covering production techniques and post-harvest handling. Farmers were trained to produce maize that meets buyers' quality standards (e.g. proper drying and sorting), and were guided on accessing credit, crop insurance, and agri-advisory services to bolster their capacity.

Results and Adaptive Learning: The pilot implementation yielded impressive initial results that validated the MCM approach. Maize production in the target districts rose from about 1,390 tons in 2021 to 12,488 tons in 2025 – about nine times more during the four years. Likewise, the total value of maize sold by participating farmers increased from roughly \$263,107 to \$3,122,031 as farmers transitioned from subsistence cultivation to market-oriented production, and new farmers in the community started commercial maize farming. In this process, farm households benefited not only from higher yields but also from better prices: the average farm-gate price of maize grain increased by roughly 40% over the baseline. During the period maize yield increased from 5.5t/ha to 6.5t/ha, and some commercial farmers realized the yield up to 12t/ha. Some youths and COVID returnees' migrants started commercial maize production (up to 10ha/HH) in private and public leased lands. These gains were achieved through iterative, adaptive implementation – the MCM team continuously monitored progress and solicited feedback from farmers and partners, using those insights to refine the innovation bundle (for example, adjusting the choice of maize hybrids or the timing of planting to fit local conditions). The positive outcomes also spurred greater buy-in. Seeing the success, Nepal's federal Ministry of Agriculture and Livestock Development (MOALD) co-invested about \$3.00 million to provide quality seed, machinery, and irrigation in support of the MCM sites, and expressed interest in expanding the model to additional regions. In 2025, the MoALD endorsed the MCM guideline and started implementing MCM scaling through the Centre for Crop Development and Agrobiodiversity Conservation (CCDABC) by USD investing USD 75,000 to implement MCM across six rural municipalities of three provinces in 2025/26. Drawing the lesson from this year, MoALD is planning to expand MCM across Terai and valleys to enhance self-sufficient and import substitution in maize.

1.4 Enabling Environment for Scaling

A conducive enabling environment has been fundamental to the MCM initiative's scaling efforts. **Policy Support and Government Commitment:** The Nepal government's strategic emphasis on maize commercialization laid the groundwork for MCM. The Honorable Minister of Agriculture has reinforced maize as a national priority to improve food, feed and fodder security while boosting farmer incomes. This high-level backing translated into tangible support: MOALD and the Department of Agriculture worked closely with CIMMYT to integrate MCM into provincial programs, and provincial governments allocated resources and staff to maize commercialization networks. The Agriculture Development Strategy (ADS) and related policies provided a supportive policy framework by highlighting the need for value chain development and import substitution in maize.

Moreover, the government's financial and institutional support was a key enabler. As noted, MOALD directly invested in inputs and infrastructure (e.g. seeds, machinery, irrigation) to catalyze the MCM rollout. Local governments in pilot areas also offered co-funding for farmer training and helped mobilize farmer groups. This public investment signaled confidence in the model and reduced risk for smallholders transitioning to commercial production.

Market and Infrastructure Environment: On the market side, Nepal's expanding poultry sector – while a challenge due to import reliance – also represents a strong pull factor for scaling maize. The existence of a ready market (feed mills ready to purchase domestic grain) created incentives for farmers to engage in MCM, provided the linkage was facilitated. The MCM project leveraged this by brokering agreements between cooperatives and feed companies, effectively guaranteeing a market for increased production. Improvements in rural infrastructure, such as feeder roads and storage facilities, further enabled scaling by reducing transaction costs. However, the initiative also identified gaps that need addressing to solidify the enabling environment. For instance, stakeholders highlighted the need for more grain storage and drying facilities near production zones to maintain quality and reduce post-harvest losses. Addressing such infrastructure bottlenecks (through public-private investment in village-level warehouses and dryers) is seen as crucial for sustaining large-scale commercial maize operations.

Policy and Regulatory Environment: A lesson from the scaling assessment is that certain national policies and regulations may need updating to fully support the maize sector's growth. One example is Nepal's Feed Act (1976) – updating this regulation and establishing modern maize quality standards were recommended to ensure locally produced maize can competitively meet feed industry requirements. Accordingly, national standard for feed grade maize was drafted by a committee formed in the leadership of Deputy Director General of Department of Livestock Services, and the document is now at MoALD for review. Additionally, the introduction of smart incentives was discussed, such as targeted grain procurement subsidies or minimum price guarantees for maize sold through cooperatives. One local government (Thakurbaba Municipality of Bardiya) provided USD 71,000 to one cooperative to support farmers on product aggregation and marketing. Such incentives could encourage more farmers to adopt the commercial model and assure them of reward for quality production. The ongoing development of a National Maize Commercialization Strategy by MOALD (as noted in a 2024 conference) further illustrates the enabling environment aligning with MCM's objectives. This strategy is expected to institutionalize support for maize value chain coordination, research-extension linkages, and investment in maize-focused agribusiness. In summary, the MCM experience underscores that a favorable enabling environment – supportive policies, government investment, market pull, and infrastructure – is critical for scaling bundled innovations in agriculture.

1.5 Actors and Institutions in the MCM Initiative

Scaling the MCM innovation bundle required orchestrating a diverse set of actors and institutions, each playing complementary roles.

Farmers and Farmer Organizations: At the center are the maize farmers – over 8,500 smallholder households participated in the pilot phase. These farmers were organized into over 40 producer groups or cooperatives (with >25,000 members, and >55% women), are the adopters of the new practices and varieties. Their willingness to innovate and collaborate was nurtured through continuous engagement, training, and demonstration of benefits (higher yields and profits). Farmer cooperatives proved to be pivotal institutions; they aggregated members' produce, facilitated collective input purchases, and served as the interface for contracting with buyers. The cooperatives in Banke, Bardiya, and Kailali became local champions of the MCM, showing neighboring communities the advantages of commercial maize production.

International and Research Institutions: CIMMYT spearheaded the MCM initiative, bringing in its global expertise in maize improvement and scaling science. As the technical lead, CIMMYT facilitated the provision of improved germplasm (hybrid seed), scientific advice on crop and soil management, and monitoring and evaluation support. The project was part of the USAID-supported Nepal Seed and Fertilizer (NSAF) initiative, which meant it had access to resources and a mandate to strengthen seed and fertilizer systems nationally. CIMMYT collaborated closely with the Nepal Agricultural Research Council (NARC) – Nepal’s apex national research body – to ensure local adaptability of the technologies and alignment with national research efforts. NARC scientists contributed by conducting trials of maize hybrids and guiding extension messages, thereby institutionalizing the innovations within Nepal’s research-extension system.

Government Agencies: Various government institutions were actively involved. At the national level, MOALD provided policy oversight and mobilized funding and sourced inputs as described. The Department of Agriculture (DoA) and its extension units helped implement activities on the ground, for instance by deploying extension officers to train farmers and monitor crop performance. In each target province, the Provincial Ministry of Agriculture and its Agriculture Knowledge Centers partnered in convening the multi-stakeholder maize platforms. These government entities lent legitimacy to the project and helped coordinate across districts. Local municipalities, which in Nepal have considerable responsibility for agricultural support, also participated – some municipalities passed resolutions to promote spring maize planting and allocated budget for things like subsidizing maize seed for interested farmers, and provided revolving funds for cooperatives for maize aggregation and marketing.

Private Sector Actors: The commercial orientation of MCM heavily involves private sector partners. Seed companies (some local, some international partners) were engaged to supply short duration and stress (drought and heat) tolerant the improved hybrid seeds at scale, ensuring that as demand for better seed grew, the supply chain could respond. Similarly, networks of agro-dealers in the region were enlisted to distribute fertilizers and agri-inputs to MCM farmers, often with credit or timely delivery arrangements fostered by the project. On the output end, feed millers and poultry industry representatives were crucial actors – they signaled the quality specifications for maize grain needed and, through agreements, provided a stable market for the farmers’ harvest. In 2021, for example, local feed mills purchased 30t maize grain directly from cooperative, and this figure rose to 1,100t in 2025. Also, there was dramatic reduction in price variation realized by farmers during this period due to improved maize quality and timely dissemination of feed mill maize grain price to farmers. The Feed Association of Nepal and large feed companies also participated in strategy meetings, aligning their procurement plans with the expected surge in domestic production. This close cooperation with buyers not only created market pull but also instilled confidence among farmers that the “demand side” of the equation was secure.

Development and Finance Partners: Although not always front-facing, development organizations and financial institutions played supporting roles. USAID, as a funder through NSAF, provided financial resources and convening power. Microfinance institutions and rural banks were tapped to extend credit to farmer groups for purchasing inputs or equipment, often facilitated by guarantees or interest subsidies from the project or local government. Insurance providers were introduced to offer digital crop insurance products, adding a safety net for farmers embracing the new commercial model. These ancillary actors helped reduce risk and improve the value proposition for farmers and other value-chain players, thereby accelerating adoption.

2. Methodological Approach for Developing Scaling Evaluation Frameworks

Evaluating the scaling of a bundled innovation like MCM required a holistic and learning-oriented methodological approach. The assessment combined quantitative metrics with qualitative insights to capture both the outcomes of scaling and the processes enabling those outcomes. **Table 1** presents the underlying impact pathway of MCM, outlining how the bundled activities are expected to generate intermediate and system-level changes. This pathway provided the foundation for selecting evaluation indicators, identifying key actors and functions, and structuring the scaling assessment around measurable stages of progress.

- 1. Action Research and Iterative Learning:** The MCM scaling effort was embedded in an action-research framework. This meant that the implementation itself was a vehicle for learning – data were collected throughout (on yields, farmer adoption rates, market prices, etc.), and regular reflection meetings with stakeholders were held to interpret results and adapt strategies. By treating the pilot sites as “learning labs,” the team could quickly identify which components of the innovation bundle were working well and which needed adjustment. For example, early feedback indicated that farmers were enthusiastic about the new hybrids but struggled with post-harvest drying; in response, the project emphasized training on proper drying techniques and advocated for investment in dryers. This nimble, iterative approach ensured that the scaling model was refined in real time, increasing its effectiveness and relevance to local conditions.
- 2. Key Performance Indicators and Data Collection:** The scaling assessment tracked a set of key performance indicators (KPIs) to quantify progress. These included technology adoption rates (number of farmers planting hybrid maize and using recommended practices), land coverage (hectares under commercial maize), productivity outcomes (yield per hectare gains), and market/economic outcomes (total volume of maize produced and sold, farmgate price trends, farmer income changes). As noted, the pilot monitoring showed significant improvements on many of these fronts – e.g. maize yield and production doubled, sales tripled, and prices rose for participants. Household surveys and field measurements were used to gather these data, with 2020/21 as a baseline and 2021/22 as a first scaling year comparison. In addition, the team employed GIS tools and field scouting to estimate the expanse of fallow land brought under maize, which helped quantify the untapped production potential being realized. The same set of KPIs will guide the staged assessments planned for 2026–2028, as outlined in Section 6, ensuring consistency in measurement and allowing partners to track progress over time.
- 3. Value Chain and Network Analysis:** Beyond farm-level metrics, the evaluation looked at value chain performance and coordination as a measure of scaling system health. The formation of multi-stakeholder networks was one such indicator – by 2022, provincial maize commercial platforms were active and meeting regularly, which was documented as a structural outcome of the project. The assessment team conducted stakeholder interviews and network mapping to evaluate how information and resources flowed among actors compared to before. They found improved coordination and service delivery; for instance, input suppliers reported better forecasting of seed demand, and feed mills reported more reliable local grain procurement – qualitative evidence that the innovation bundle’s institutional components were taking root. These findings reinforced the idea that scaling was not just about more technology in farmers’ hands, but about stronger linkages across the system.
- 4. Scaling Readiness Perspective:** The MCM evaluation was informed by the broader Scaling Readiness framework of CGIAR, which emphasizes assessing both innovation performance and the “readiness” of the context to support scaling. In practice, this meant examining which elements of the MCM bundle were mature and widely adopted versus which elements required further development or enabling actions. For example, on the technological side, the availability of suitable maize hybrids was high (several proven varieties were accessible), but on the institutional side, certain policies (like the outdated Feed Act) lagged behind, potentially constraining long-term scaling. By identifying such gaps, the assessment could formulate recommendations to strengthen the overall scaling environment. Indeed, the 2020–2022 study recommended adopting a comprehensive value chain approach in policy and investing in coordination mechanisms to sustain maize commercialization at scale.
- 5. Feedback into Strategy:** The methodological approach ensured that evaluation insights fed directly into strategy adjustments and future planning. The “Next steps” jointly identified by CIMMYT, government, and private partners – such as the need for stress-tolerant short-duration maize varieties, contract farming models, and grain storage investments – emerged from the scaling assessment process. These findings have informed both the expansion of MCM to new districts and the national strategy discussions on maize. In essence, the scaling evaluation was not a one-off post-mortem exercise, but a continuous guiding tool that shaped how the initiative evolved and how resources were allocated for maximum impact.

Table 1. Impact Pathway of the MCM

Activities	Participants	Output	Expected (intermediate) effect
Establishing a maize commercial network	Farmers cooperatives, traders, extension departments, feed mills, input dealers, feed mills	- Information about government schemes for agricultural inputs - Better information on buyers, markets, quality grades, prices, and knowledge of commercial farming.	- Increase crop yield and gross margin from maize production. - Increase HH area under maize. - Increase HH investment in maize business (e.g. assets, leased land) - Increase % of HH maize grain sold in the market - New household income source from maize - Impacts on women's income - Increased stability of income from maize - Women's empowerment from maize production
Training on BMPS (crop variety, soil fertility, irrigation, plant protection, post-harvest and marketing)	Farmers with at least 50% women.	- Use best management practices - Use of 4Rs of nutrient management – right time, right source, right rate and rate place of fertilizer application.	
Demonstration of maize varieties and best management practices (BMPs) Farmers' field days	Farmers, Extension agents	- Improved knowledge about seed varieties - Improved knowledge about BMPs for maize	
Fall Armyworm management campaign	Farmers, traders	- Improved knowledge of pest identification and management - Reduced loss from pest attack	
Linkage with feed mills and buyers	Farmers, traders, feed mills	- Higher price of maize - Timely sale of maize	

By combining rigorous data tracking with participatory stakeholder learning, the MCM scaling assessment provided a 360-degree view of the innovation's progress and its interaction with the context. This comprehensive methodological approach ensured that the evaluation captured the full complexity of scaling a bundled innovation – from yield gains and farmer uptake to network building and policy influence. It also exemplified a “learn-as-you-scale” paradigm: evaluation was woven into implementation, thereby reinforcing the success of the MCM initiative and laying a stronger foundation for its scale-up across Nepal's maize-growing regions. Moreover, the MCM scaling experience in Nepal highlights the importance of integrated solutions, supportive ecosystems, multi-actor partnerships, and adaptive learning in achieving sustainable agricultural transformation at scale. The positive outcomes to date – increased maize productivity, income gains for farmers, and enhanced coordination in the maize sector – testify to the effectiveness of the bundled innovation approach, while the lessons learned are guiding further scaling efforts both in Nepal and in similar contexts aiming to boost food security through innovation.

3. Characterizing Bundled Innovations as Integrated Innovation Packages

Designing effective scaling strategies for agricultural innovations requires moving beyond the evaluation of individual technologies to understand how innovation bundles function as integrated systems. This section introduces a structured approach for characterizing crop diversification and mechanization bundles as system-level innovation packages. It draws on the experience of the MCM initiative to identify the key components, complementarities, and enabling structures that collectively determine scaling potential.

Defining the Innovation Bundle: A bundled innovation is not a simple aggregation of technologies, but a configuration of interdependent elements – technical, organizational, and institutional – that must be delivered together to be effective. In the MCM initiative, the bundle comprises improved maize hybrids, crop management practices, mechanization, market contracts, and extension support, embedded within a network of service providers, cooperatives, and value chain actors. This system-level design aligns with the notion of “integrated innovation packages” proposed in scaling literature, where success depends on both the innovation and the readiness of the context that hosts it.

Component Roles and Interactions: Each component within the bundle serves a distinct function, but their performance is co-dependent. For example, the yield advantage of hybrid seeds is conditional on timely planting and adequate nutrient supply, which require mechanization and fertilizer access. Likewise, market arrangements with feed mills only materialize if grain quality and volume thresholds are met – both influenced by agronomy, aggregation, and post-harvest practices. These interaction effects mean that components are not substitutable and must be synchronized for optimal results. Frija et al. (2024) emphasize that scaling readiness in such systems cannot be assessed component-wise; instead, performance must be evaluated for the bundle, recognizing bottlenecks introduced by the least ready element or weakest link in the institutional environment.

Core vs. Complementary Innovations: A key step in structuring bundles is distinguishing core innovations (those that directly drive productivity and income gains) from complementary elements that enable, amplify, or stabilize those gains. In MCM, the core elements include hybrid seed deployment, mechanized operations, and best management practice (BMP) training, together with basic market access that ensures farmers can sell increased production without major losses. Complementary elements include digital advisories, aggregation infrastructure, pest surveillance systems, improved post-harvest handling, quality grading, cooperative-led aggregation, contract arrangements with feed mills, and pricing mechanisms that reward timely delivery and better grain quality. These marketing-related components strengthen the commercial viability of the core package by reducing transaction costs, improving bargaining power, and ensuring consistent buyer confidence. This distinction is critical for designing scalable models: core elements define the essential package, while complementary elements shape where, how, and how fast the package can succeed across different contexts.

Functional Architecture and Actor Roles: Characterization also involves mapping the architecture of the bundle: how functions are distributed among actors and how components are delivered. In MCM, seed companies and agrovets ensure input supply; cooperatives facilitate aggregation and training; government agencies provide technical backstopping; and feed mills signal demand and quality standards. This architecture resembles what Frija et al. (2024) refer to as a “system readiness configuration,” where scaling success hinges on the orchestration of actors across functions such as supply, extension, finance, and market intermediation.

Complementarity and Synergies: Synergies are central to the performance and scaling potential of bundled innovations. The adoption of one component often enhances the effectiveness of others. For example, when improved seed delivers greater yield gains only if combined with timely mechanization, optimal nutrient management, or reliable irrigation. These interdependencies are not incidental; they reflect the systemic nature of agricultural innovation, where multiple constraints must be addressed simultaneously. Vanlauwe et al., 2014 show that conservation agriculture fails to deliver unless soil fertility, crop residue management, and fertilizer access are bundled appropriately, underscoring that single interventions often yield limited impact in isolation. Similarly, Duflo et al. (2011) find that input adoption and productivity gains increase significantly when technologies are paired with complementary services (e.g., market linkages). Beyond technical interactions, such complementarities extend into institutional and behavioral domains (e.g., trust in cooperatives, reliability of service provision, and collective action). This interconnectedness complicates attribution but strengthens the rationale for treating the bundle (not its individual parts) as the unit of analysis in scaling evaluations.

Contextual Fit and Adaptability: The scalability of a bundle also depends on its fit with local contexts. In Western Terai, for example, spring fallows, access to irrigation, and demand from feed mills created favorable conditions for adoption (Woli 2024). Mechanization aligned with labor constraints, and women's active role in maize cultivation increased the relevance of training and cooperative engagement. However, context-specific customization (such as hybrid selection, planting calendars, or buyer arrangements) remains necessary. The bundle must offer a "core-plus-adaptable" model that retains essential functions while allowing for recombination in new settings. As Wigboldus et al. (2016) argue, scaling is not simply about replicating a fixed solution across locations but about understanding how an innovation interacts with diverse ecological, institutional, and socio-economic contexts. Successful scaling strategies must therefore embed on adaptive design, enabling actors to reconfigure innovative elements to align with local structures, capacities, and constraints. This perspective reinforces the need to treat bundles not as rigid packages, but as modular systems whose relevance and performance hinge on how well they fit – and evolve within – specific environments.

Implications for Scaling Design: This structured characterization of innovation bundles offers three practical implications for scaling design: (i) defining core and complementary components helps partners understand which elements are non-negotiable and which can be tailored, (ii) mapping functional roles clarifies which actors need to coordinate and what capacities are required, and (ii) identifying complementarities and pathway fitness helps predict bottlenecks and guide investment in enabling conditions. These steps lay the foundation for robust scaling strategies that treat innovations as embedded within systems, rather than isolated technical fixes.

4. Methods for Assessing Scaling Readiness, Scaling Processes, and System-Level Outcomes

This section describes the practical methods used to assess the scaling readiness, scaling processes, and system-level outcomes of crop diversification and mechanization bundles, using MCM as the empirical foundation. The approach integrates evidence from the commercialization analysis, the Bardiya Scaling Scan, and field implementation reports to provide a structured assessment system suitable for government partners, cooperatives, private sector actors, and CGIAR teams.

The Bardiya Scaling Scan refers to a structured diagnostic exercise conducted in Bardiya district, Nepal, to assess the scaling readiness of MCM using the Scaling Scan tool. This tool, originally developed by PPP Lab and further applied by CGIAR and partners, is used to assess how ready an innovation is to scale by examining a broad set of conditions.

To assess scaling readiness, scaling processes, and system-level outcomes effectively, it is essential to distinguish how bundled innovations differ from individual technologies in both structure and behavior. Bundles such as those in the MCM model combine multiple interdependent technologies, practices, institutions, and market functions that must operate together to deliver meaningful impact. As a result, the assessment must shift from evaluating isolated components to examining the performance of the entire package within the wider system. The table below summarizes the key differences between assessing single innovations and integrated innovation bundles, highlighting why scaling evaluations for bundled approaches require system-oriented methods, multi-actor diagnostics, and attention to complementarity and coordination effects. These differences are listed in **Table 2**.

Table 2: Differences Between Assessing Single Innovations and Bundled Innovations

Dimension	Assessment of Single Innovations	Assessment of Bundled Innovations (Integrated Innovation Packages)
Unit of analysis	A single core technology or practice (e.g., seed variety, machine, advisory tool).	A configuration of interdependent technologies, practices, service models, institutions, and market arrangements.
Framing	Innovation-centric; complementary elements viewed mainly as add-ons or bottlenecks.	System-centric; the bundle and its enabling conditions are treated as one integrated package.
Readiness assessment	Readiness is judged mainly by maturity, performance, and usability of core innovation.	Readiness assessed across multiple components, with the bundle constrained by the least ready element and the system's readiness to host the package.
Enabling conditions	Considered indirectly; gaps are noted but assessed relative to a single innovation.	Explicitly evaluated; enabling conditions (institutions, markets, policies, finance) are part of the package architecture.
Complementarities & interactions	Minimal; impacts assumed to be attributable to the core innovation.	High; interaction effects and synergies across components drive outcomes. Evaluation must capture complementarities.
Scaling processes	Often conceptualized as diffusion (awareness → trial → adoption).	Viewed as coordination processes requiring actor alignment, timing across components, and bundle recombination in new contexts.
Role of actors	Focus on users and extension agents.	Multi-actor: cooperatives, service providers, municipalities, private buyers, finance institutions.
Implementation models	Typically uniform across locations.	Often adapted across districts; bundles vary in composition and delivery, requiring tracking of configuration changes.
Outcome attribution	Easier; marginal effects can be estimated more cleanly.	Harder; outcomes arise from joint effects, making attribution to individual components difficult. Package-level impact estimates are more appropriate.
Evaluation design	Randomized trials or simple econometric comparisons are often sufficient.	Requires mixed methods: package-level impact evaluation, actor–function mapping, process tracing, enabling environmental diagnostics.
System-level outcomes	Limited to direct effects on adoption or productivity.	Broader effects on market functioning, institutional capacity, coordination, gender inclusion, and value-chain transformation.
Scalability criteria	Focus on the adoption potential and cost-effectiveness of a single innovation.	Focus on system readiness, institutional strength, market coherence, and actor coalitions necessary for sustained scaling.

4.1 Assessing Scaling Readiness

Scaling readiness is evaluated by examining whether the innovation bundle and the system around it is prepared for expansion beyond initial project sites. It uses a mix of qualitative scoring (adapted from the Scaling Scan tool) and quantitative indicators (e.g., adoption rates, mechanization access, and stable contracting volumes). The assessment combines four readiness dimensions:

1. **Innovation Readiness:** This examines whether the technical components are mature, usable, and effective under farmer conditions. For MCM, readiness is demonstrated through hybrid seed performance, agronomy training modules, mechanization service availability, and validated BMPs. Evidence from the empirical analysis shows higher yields among participants and consistent performance across male- and female-headed households, indicating robustness of the core innovations.
2. **Context Readiness:** This assesses agroecological suitability, labor dynamics, infrastructure, and local cropping patterns. In Western Terai, spring fallows, irrigation availability, and high feed demand create favorable conditions for scaling. Mechanization aligns with labor shortages due to outmigration. These contextual features reduce adaptation requirements and strengthen the potential for wider uptake.
3. **Organizational Readiness:** This involves evaluating whether cooperatives, municipalities, and service providers have the capacity to sustain delivery of bundle components. Indicators include cooperative aggregation volumes, training delivery capacity, and linkages with input suppliers. The Bardiya Scaling Scan highlighted strengths in “knowledge and skills” and “collaboration” but identified “ownership” and “monitoring” as areas requiring improvement, providing a realistic profile of readiness.
4. **Partnership Readiness:** Scaling requires alignment between private actors (seed companies, agrovets, traders, feed mills) and public agencies. Assessments focus on contract reliability, buyer interest, pricing stability, and the willingness of cooperatives to coordinate aggregation. The expansion of maize supplied to feed mills, documented in project reports, indicates strong partnership readiness.

4.2 Assessing Scaling Processes

Scaling processes involve tracking how the bundle moves from pilot implementation to wider adoption. This requires monitoring the actors, actions, and interactions that support scale. Together, these methods provide a dynamic picture of how scaling unfolds and where intervention is needed.

1. **Adoption and Use Patterns:** Methods include tracking adoption of hybrid seeds, mechanization services, BMPs, FAW management practices, and post-harvest techniques. Adoption is assessed through farmer surveys, cooperative records, training attendance lists, and digital advisory usage statistics. Gender-disaggregated analysis helps identify whether scaling is inclusive.
2. **Actor Coordination and Role Evolution:** Scaling depends on how well cooperatives, municipalities, extension agents, and market actors coordinate. Process mapping is used to document role clarity, service flows, and communication pathways. The MCM actor–function–enabler model (cf. Figure 1) provides a structure for assessing whether scaling strengthens coordination or reveals gaps.
3. **Expansion Pathways and Replication:** This method assesses whether the bundle is being taken up by new municipalities, cooperatives, or private actors, and whether replication requires adaptation. Indicators include the number of new groups adopting the bundle, geographic spread, and continuity of services after project withdrawal.
4. **Enabling Environment Adjustments:** Scaling processes are influenced by policy support, subsidy access, and institutional mandates. Monitoring includes assessing whether municipalities allocate budgets to mechanization, extension, or aggregation; whether cooperatives form new contracts; and whether private actors expand service offerings.

4.3 Assessing System-Level Outcomes

System-level outcomes capture the broader effects of scaling beyond direct adoption. They help determine whether scaling contributes to food system transformation.

1. **Productivity and Production Outcomes:** These include yield gains, expanded spring maize area, and volume aggregated through cooperatives. Empirical estimates of treatment effects and descriptive statistics from the commercialization analysis support outcome evaluation.
2. **Income and Market Outcomes:** Measures include changes in gross margins, price realization, stability of buyer relationships, and diversification of income sources. Cooperative sales records and trader/feed mill contracting information serve as primary data sources.
3. **Social and Gender Outcomes:** System-level indicators include improved participation of women in training, equitable yield gains, reduced drudgery through mechanization, and enhanced decision-making. Evidence from the dataset shows significant benefits to female-headed households when participating in the bundle.
4. **Institutional Outcomes:** Assessment focuses on cooperative capacity, governance improvements, and sustained service delivery. Increased aggregation volumes and expanded local mechanization networks are central indicators.

5. Positioning the Frameworks for Use by Partners and Alignment with CGIAR's S4I

The scaling evaluation frameworks developed in this report are designed to be directly usable by government agencies, cooperatives, private-sector actors, and CGIAR teams. They align structurally and conceptually with the CGIAR S4I program, which integrates scaling science and practice to support large-scale, partner-led agrifood system transformation. S4I places stakeholder engagement, innovation pathway design, enabling environment support, large-scale investment mobilization, and continuous learning at the core of its operations. The frameworks developed here map closely onto these functions, enabling seamless adoption and use across the scaling ecosystem.

5.1 Alignment with S4I's Areas of Work (AoW)

This report is developed as part of AoW-2 (Pathways to Scale) of the CGIAR Scaling for Impact (S4I) Program. Its primary contribution is to provide practical methods and tools that help partners design, organize, and implement scaling pathways for bundled innovations such as the Maize Commercialization Model (MCM). The framework presented here operationalizes AoW-2 by offering a structured way to characterize innovation bundles, identify core and complementary components, diagnose readiness, and track scaling processes as they unfold in real settings.

AoW-2 (Pathways to Scale) is the core anchor for the report. The methodology aligns closely with S4I's emphasis on multistakeholder scaling hubs, co-design of bundled solutions, and development of pathways that are adapted to local constraints and opportunities. The framework strengthens AoW-2 in the following ways:

- **Characterizing innovation bundles:** It provides a clear method to define core and complementary elements within MCM, showing how technologies, services, market arrangements, and institutional functions must be aligned before scaling.
- **Mapping actor roles and functions:** It supports AoW-2 by identifying which actors deliver which components, where coordination is strong or weak, and how responsibilities shift as scaling progresses.
- **Diagnosing readiness for scaling:** It incorporates readiness assessments that reflect the maturity of components, system preparedness, GESI gaps, and enabling-environment conditions—core inputs for designing viable pathways.

- **Embedding GESI within scaling pathways:** Gender and social inclusion are considered integral to pathway design, ensuring that scaling plans address barriers related to time, mobility, decision-making, access to mechanization, and market participation.
- **Tracking scaling processes:** The framework includes practical tools to monitor adoption trajectories, bundle adaptation in new contexts, institutional evolution, and partnership development—key elements of AoW-2 operational logic.
- **Supporting adaptive pathway design:** Evidence from adoption trends, coordination patterns, and system-level outcomes feeds back into iterative pathway refinement, following the “learn while scaling” approach emphasized in S4I.

AoW-1 (Engage & Empower): The readiness and context-diagnostic tools developed here draw from S4I’s demand–supply alignment mechanisms, supporting partners to signal priorities and ensure the innovation bundle addresses local needs.

AoW-3 (Enabling Environment Lab): The framework incorporates enabling-environment diagnostics that reflect OP-3.1 and OP-3.2, which call for identifying policy constraints, strengthening institutions, and providing targeted technical assistance for scaling.

AoW-4 (Achieving Impact): By generating structured evidence on the performance of bundled innovations, the framework provides inputs for OP-4.1 and OP-4.2, supporting integration of solutions into government and IFI investments and new partnerships with value chain actors.

AoW-5 (Learning for Impact): The system-level outcomes indicators and monitoring guidance align with S4I’s MELIA strategy, particularly dynamic scaling evaluation (CoA-5.2), which examines diversified and deep scaling outcomes and identifies trade-offs across pathways.

5.2 Usability for Government Agencies

The scaling framework provides structured diagnostic tools that mirror S4I’s emphasis on demand-led prioritization, enabling governments to evaluate scaling entry points, required investments, and institutional capacity. S4I’s OP-1.1 and OP-1.3 emphasize generating demand signals and creating forward-looking scaling strategies for national systems. The MCM framework operationalizes these functions at district and municipal levels by enabling agriculture offices and AKCs to:

1. co-design/assess scaling readiness using standardized criteria consistent with Scaling Readiness and Scaling Scan approaches (CoA-2.1)
2. scaling pathways with cooperatives and private-sector actors using evidence from the evaluation framework (CoA-2.2)
3. prioritize investments in mechanization, advisory services, aggregation, and seed delivery systems
4. align indicators with governmental MEL systems, consistent with S4I’s emphasis on national co-monitoring and evaluation arrangements
5. This allows government agencies to apply the framework without needing new institutional structures.

5.3 Application by Cooperatives and Local Institutions

Cooperatives play a central role in S4I's design, as they are part of the enabling environment and institutional pathways (OP-3.2, OP-4.2). The MCM scaling framework enables cooperatives to:

1. conduct internal capacity assessments aligned with S4I's institutional strengthening mandate
2. identify gaps in aggregation, service delivery, financial management, and market coordination
3. use performance indicators – such as grain volumes, input distribution coverage, and service reliability – to negotiate better partnerships with traders and feed mills
4. participate directly in scaling pathway co-design hubs envisioned under S4I (OP-2.1)

This makes cooperatives active agents in scaling processes, consistent with S4I's vision for partner-led, context-embedded scaling.

6. Proposed Staggered Approach for MCM Assessments (2026–2028)

The assessments can follow a phased structure, where each year builds on the previous one. The idea is to (1) update the evidence base, (2) deepen analysis of scaling processes, and (3) track system-level outcomes as MCM expands. Gender equity, youth and social inclusion (GEYSI) should be built into each year's assessment rather than treated as a separate component. The three-year plan below embeds GEYSI in readiness diagnostics, monitoring, and system-level evaluation.

6.1 Activities 2026: Updated baseline and readiness assessment (with full GEYSI diagnostics)

Purpose: To create a 2025-anchored baseline that already reflects gender gaps, social inclusion gaps, and readiness levels across all bundle components.

Focus areas:

- Update the entire MCM dataset to 2025.
- Conduct a full scaling readiness assessment that includes:
 - Gender-disaggregated adoption and performance patterns.
 - Cooperative readiness for women's participation (leadership, service access, decision roles).
 - Inclusion of young farmers, land-poor farmers, and migrants' households.
- Re-estimate the Bardiya Scaling Scan dimensions with explicit attention to whether women and socially disadvantaged groups are benefiting from training, mechanization services, aggregation, and advisory systems.
- Identify GEYSI-linked bottlenecks such as access to irrigation slots, timing conflicts between training and women's workload, barriers to women's and youth's market participation, and credit constraints for smaller farmers.
- Produce district-wise readiness maps that show where scaling can proceed without leaving behind women and disadvantaged groups.

This makes cooperatives active agents in scaling processes, consistent with S4I's vision for partner-led, context-embedded scaling.

6.2 Activities 2027: Monitoring scaling processes and emerging outcomes (with continuous GEYSI tracking)

Purpose: To understand how the bundle is spreading and whether the scaling process is equitable.

Focus areas:

- Track adoption of hybrid seed, mechanization, and BMPs by gender, age-groups, caste, landholding, and migrant status.
- Document changes in women's and youth participation in cooperatives, training sessions, and Buyer–Seller meetings.
- Analyse how actor roles are shifting, with questions such as
 - Are women involved in aggregation and quality sorting?
 - What are the major constraints that youth faces to involve in service provision?
 - Do cooperatives adjust service timing to match women's availability?
- Monitor whether bundle adaptation in new municipalities supports or excludes women and marginal groups.
- Assess early GEYSI outcomes:
 - Drudgery reduction from mechanization.
 - Change in women's decision-making in maize production.
 - Whether increased market linkages benefit or bypass smaller producers

6.3 Activities 2028: System-level outcomes and long-term scaling strategy (with a strong GEYSI lens)

Purpose: To understand how the bundle is spreading and whether the scaling process is equitable.

Focus areas:

- Evaluate productivity, income, price realization, and stability of buyer relationships across gender, caste, and land size groups.
- Assess institutional outcomes:
 - Cooperative governance and representation of women and disadvantaged groups.
 - Quality of service delivery for low-literacy or land-poor farmers.
- Examine whether system-level changes are inclusive:
 - Are women and small farmers gaining sustained access to markets?
 - Are contracts with feed mills equitable for smaller producers?
- Identify where the MCM bundle needs adaptation for different social groups.
- Produce a consolidated three-year assessment (2026–2028) and a long-term inclusive scaling roadmap for government and S4I partners.

Table 3: Operational budget for assessments (2026–2028)

Cost Item	2026	2027	2028	Notes
Household surveys (gender-disaggregated)	USD 40,000	USD 25,000	USD 25,000	Baseline larger; follow-up lighter
Cooperative and actor interviews	USD 10,000	USD 8,000	USD 8,000	Includes traders, feed mills, agrovets
GEYSI-focused qualitative studies	USD 15,000	USD 12,000	USD 12,000	FGDs with women, youth, smallholders
Scaling Scan / readiness assessments	USD 12,000	USD 8,000	USD 10,000	Includes network mapping
Field travel and supervision	USD 20,000	USD 18,000	USD 18,000	Nepal-wide coordination
Data cleaning + analysis	USD 15,000	USD 12,000	USD 12,000	Includes disaggregated reporting
Partner workshops + validation	USD 8,000	USD 6,000	USD 10,000	Includes provincial and national meetings
Total operational cost	USD 120,000	USD 89,000	USD 95,000	Does not cover staff time

7. Conclusion

MCM demonstrates how bundled innovations – integrating technologies, institutional linkages, and market arrangements – can address systemic constraints in smallholder agriculture and create viable pathways for scaling. Unlike single interventions, the effectiveness of MCM lies in the interplay between seed quality, agronomy, mechanization, cooperative strength, and market coordination. This report has proposed a practical framework to assess the scaling readiness, processes, and outcomes of such innovation bundles in real-world settings. The structured approach includes clear criteria for defining core and complementary components, identifying enabling actors and functions, and tracking adoption, actor coordination, and system-level changes over time. It also highlights the importance of contextual fit, iterative learning, and actor alignment in ensuring that bundles scale equitably and sustainably. Lessons from the implementation in Nepal – particularly from Bardiya and neighboring districts – show that successful scaling depends not only on innovation performance but also on functional ecosystems, responsive institutions, and strong local engagement.

Positioned within the CGIAR S4I framework, this methodology supports partners in embedding MCM-like models within national systems and broader portfolios. By treating the bundle as the unit of analysis and integrating monitoring with adaptive learning, the framework strengthens evidence-based decision-making and portfolio-level scaling strategies. These insights can inform other programs working on crop diversification, mechanization, or commercialization in similar contexts.

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